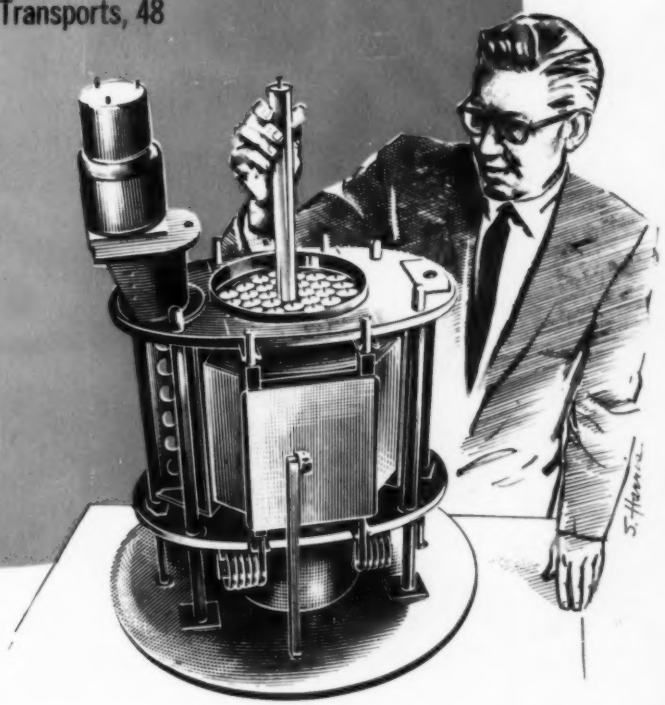
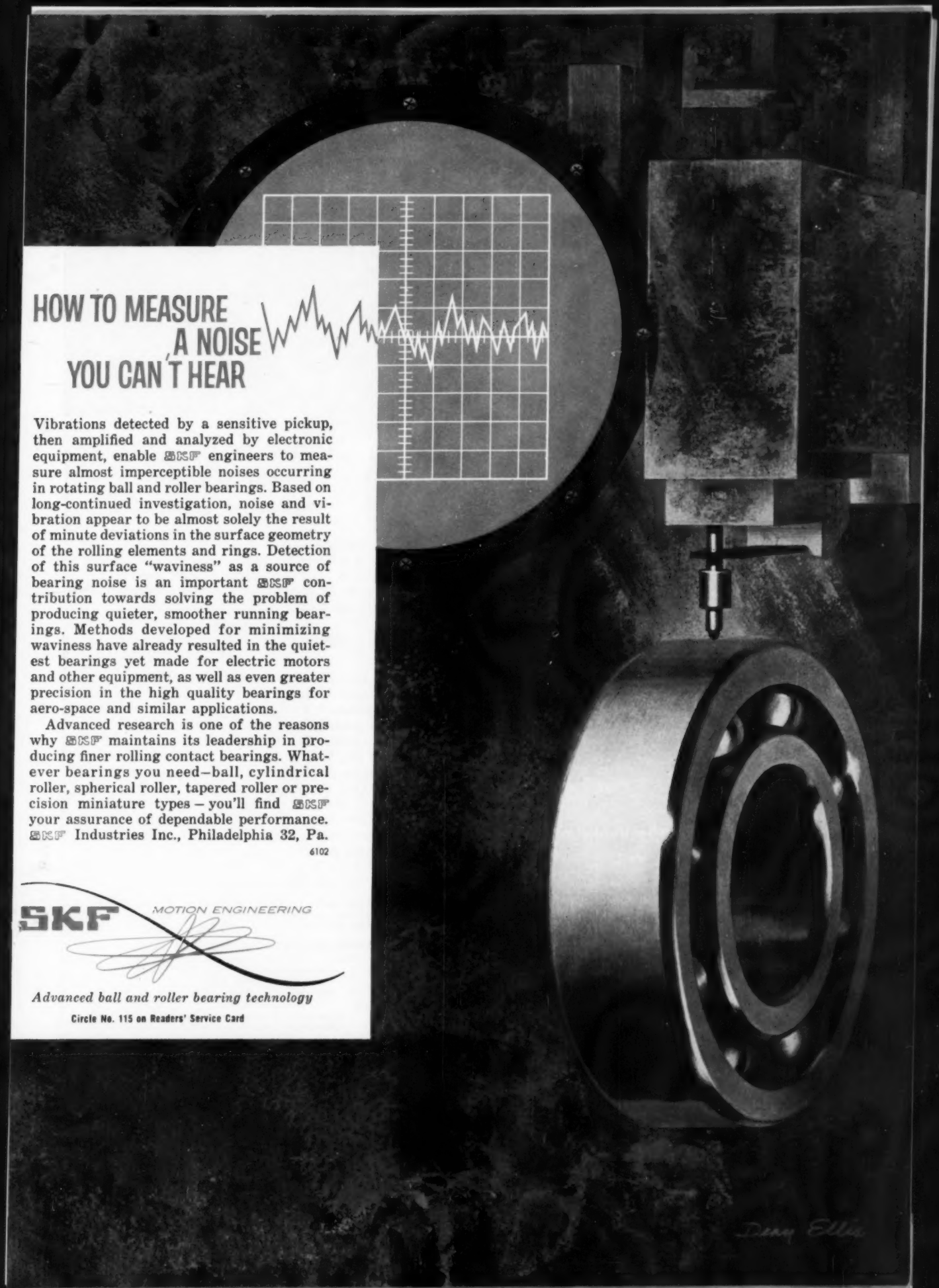
MECHANICAL ENGINEERING

April 1961



Compact Nuclear Reactor



HOW TO MEASURE A NOISE YOU CAN'T HEAR

Vibrations detected by a sensitive pickup, then amplified and analyzed by electronic equipment, enable SKF engineers to measure almost imperceptible noises occurring in rotating ball and roller bearings. Based on long-continued investigation, noise and vibration appear to be almost solely the result of minute deviations in the surface geometry of the rolling elements and rings. Detection of this surface "waviness" as a source of bearing noise is an important SKF contribution towards solving the problem of producing quieter, smoother running bearings. Methods developed for minimizing waviness have already resulted in the quietest bearings yet made for electric motors and other equipment, as well as even greater precision in the high quality bearings for aero-space and similar applications.

Advanced research is one of the reasons why SKF maintains its leadership in producing finer rolling contact bearings. Whatever bearings you need—ball, cylindrical roller, spherical roller, tapered roller or precision miniature types – you'll find SKF your assurance of dependable performance. SKF Industries Inc., Philadelphia 32, Pa.

6102

SKF MOTION ENGINEERING

Advanced ball and roller bearing technology

Circle No. 115 on Readers' Service Card

New Series of Marsh Needle Valves in 316 STAINLESS STEEL

—Valves that take you out of your corrosion problems

Now still wider service range for the valves that have set new standards in the needle throttling field. A full line of Marsh Needle Valves are immediately available in 316 stainless steel in the new series 1936.

Identified by blue handles

Here is a valve that opens up the wide range of corrosion-resistant applications bracketed by 316 stainless. It is a valve that gives precision throttling at pressures from a few pounds through 6000 psi . . . a valve for any temperature from minus 100° F. to plus 500° F. thanks to the "Marpak" packing system making use of precision moulded Teflon.

Only Marsh experience—in both valve making and instrument making—could have produced these valves. Like other Marsh needle valves, they are available in globe and angle patterns and in panel mounted types; sizes, ⅛", ¼", ⅜", ½", ¾" and 1". The 316 stainless valves are fully described in Bulletin NV-3.

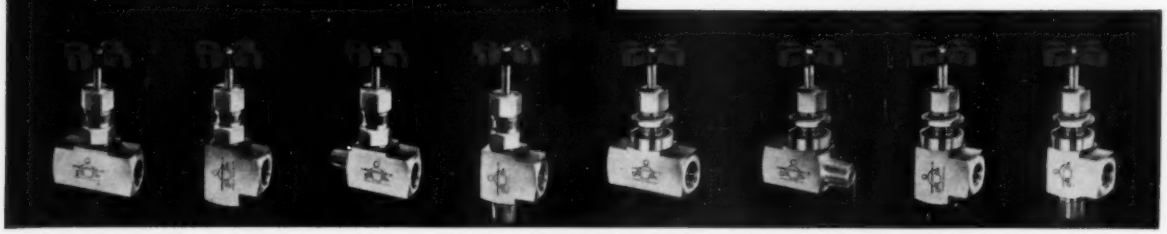
Marsh Needle Valves are also available in 416 stainless steel (identified by green handles) and in mild steel (identified by yellow handles.)

The Marsh touch—
the precision touch—in every detail

- Body and stem guide machined from 316 stainless bar stock.
- Accurately machined stem, precision ground and rolled.
- Longer inlet and outlet thread chambers insure tight make-up.
- Packing as corrosion-resistant as the valve.

MARSH *Needle Valves*

MARSH INSTRUMENT COMPANY, Dept. 29, Skokie, Ill.
Division of Colorado Oil and Gas Corporation
Marsh Instrument & Valve Co. (Canada) Ltd.
8407 103rd St., Edmonton, Alberta
Houston Branch Plant, 1121 Rothwell St.,
Sect. 15, Houston, Texas
Eastern Seaboard Warehouse: Marsh Instrument Company, 1209 Anderson Ave., Fort Lee, N.J.



Circle No. 88 on Readers' Service Card

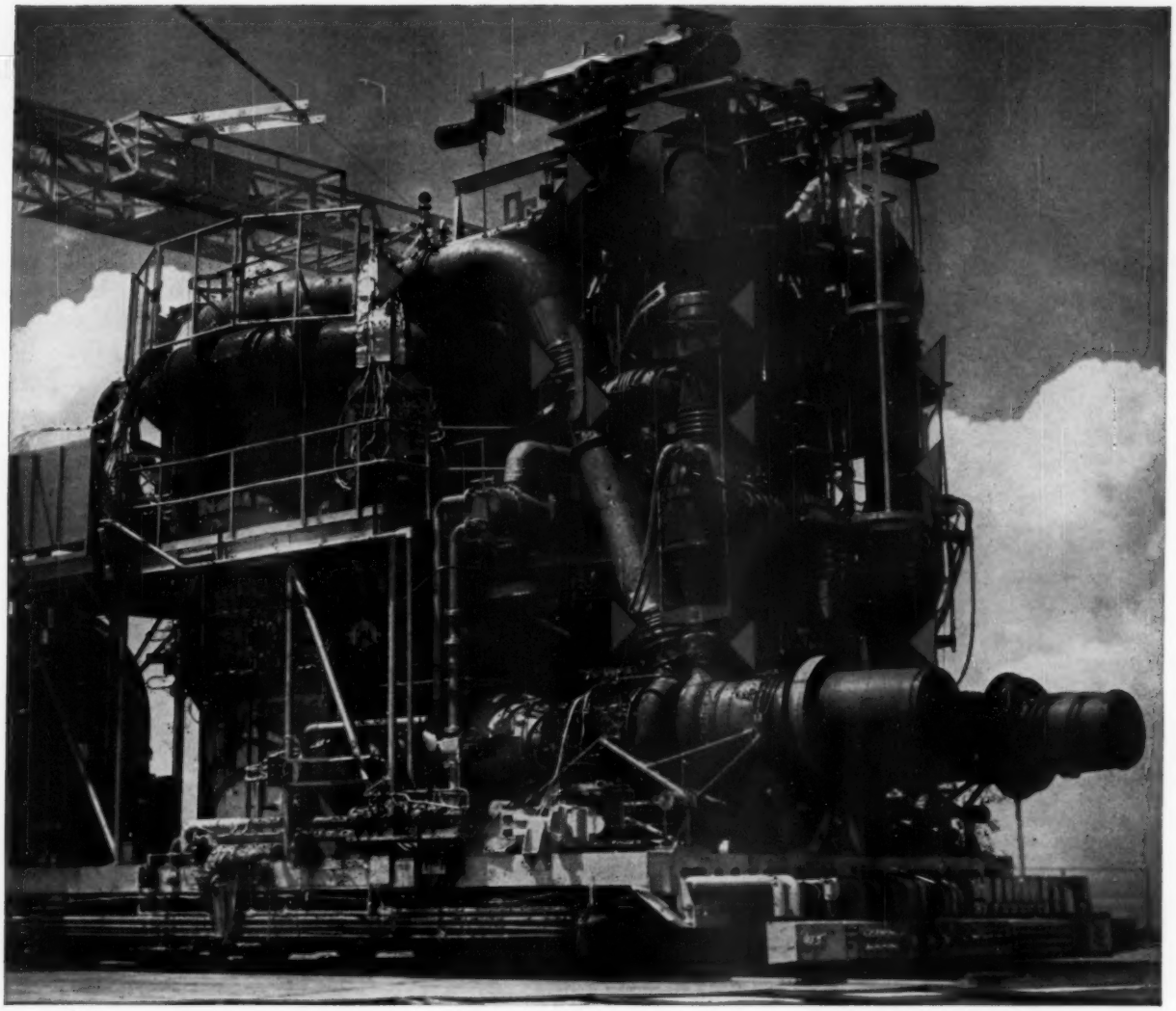
MECHANICAL ENGINEERING

PUBLISHED BY
THE AMERICAN SOCIETY OF
MECHANICAL ENGINEERS

Contents

VOLUME 83 • NUMBER 4 • APRIL, 1961

Contents continued on following page



Where expansion joint reliability really counts... YOU FIND ZALLEA

Eighteen Zallea Expansion Joints protect all the piping between compressor, reactor and turbine in General Electric's Heat Transfer Reactor Experiment (HTRE). Sizes range from 18-in. to 30-in. diam. Temperatures are 500 F and 1500 F at 53 psig.

Objectives of HTRE were to develop and test a complete aircraft nuclear power plant system, to determine operating characteristics, and to verify the design of a direct-air-cycle nuclear propulsion system. As in any research involving unknown quantities (in this case the heat source) a basic requirement for all system components was *maximum reliability*. The results of HTRE were successful. Objectives were accomplished. The integrity and life of all system components were verified.

This is another example of Zallea competence in the nuclear field. In fact, Zallea has provided the large majority of all the expansion joints used in atomic, nuclear and missile projects. Our work with almost every major engineering and manufacturing firm in these fields has given us an unequalled background of experience and engineering capacity. It can give you important savings in time and investigation when expansion is involved in piping systems or tanks.

Write for Catalog 56, which contains complete and comprehensive engineering data for Expansion Joints from 3-in. to 50-ft. diam., pressures to 3600 psi, temperatures to 1600 F.

ZALLEA BROTHERS, Taylor and Locust Streets, Wilmington 99, Delaware.

Zallea FOR MAXIMUM RELIABILITY

WORLD'S LARGEST MANUFACTURERS OF EXPANSION JOINTS

Circle No. 146 on Readers' Service Card

MECHANICAL ENGINEERING

PUBLISHED BY THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Contents (continued)

VOLUME 83 • NUMBER 4 • APRIL, 1961

Published monthly by The American Society of Mechanical Engineers. Publication office at 20th and Northampton Streets, Easton, Pa. Editorial and Advertising departments at the headquarters of the Society, 29 West Thirty-Ninth Street, New York 18, N. Y. Cable address, "Mechanize, New York." Price to members [illegible] $3.00 for initial membership subscription, $5.00 for additional subscriptions, single copy 50 cents, to nonmembers [illegible] annually $7.00, single copy 75 cents. Add $1.50 for postage to all countries outside the United States and Canada. Changes of address must be received at Society headquarters seven weeks before they are to be effective on the mailing list. Please send old as well as new address. By-Laws: The Society shall not be responsible for statements or opinions advanced in papers or [illegible] printed in its publications (B13, Par. 4). Second-class mail privileges authorized at Easton, Penna. [illegible]. Acceptance for mailing at special rate of postage provided for in section 1103, Act of October 3, 1917, authorized on January 17, 1921. [illegible]. Copyright, 1961, by The American Society of Mechanical Engineers. Member of the Audit Bureau of Circulation. Reprints from this publication may be made on condition that full credit be given MECHANICAL ENGINEERING and the author, and that date of publication be stated.

51,500 copies of this issue printed

MECHANICAL ENGINEERING is indexed by the Engineering Index, Inc.

Departments

producing URANIUM in SASKATCHEWAN
or NITRATES in CHILE . . .

NORDBERG ENGINES

continually prove their reliability and economy

Neither bitter cold, nor inaccessible location could stop the successful development of a strategically valuable uranium ore deposit by Gunnar Mines, Limited, located in northwest Saskatchewan, less than 450 miles south of the Arctic Circle.

To meet their electrical power requirements, Gunnar chose seven Nordberg Supairthermal® 4-cycle diesel engine-generator units, each rated 1200 hp at 450 rpm, direct connected to 845 kw generators. Adding to the efficiency of this installation are waste heat boilers which utilize exhaust gas from the Nordberg engines to produce steam for heating plant buildings.

* * *

The story of power plant expansion for Anglo-Lautaro Nitrate Corporation's vast operations in northern Chile is largely a story of reliable Nordberg power. Their original Nordberg engine was a 7100 hp diesel unit installed in the Pedro de Valdivia plant, followed by the installation of two 1900 hp Nordberg diesels for the plant at Maria Elena. Then, to meet much needed additional power, two big 9600 hp Nordberg diesels were installed in a new power plant at Coya Sur.

Anglo-Lautaro has again turned to Nordberg to meet further power expansion, and is installing *five more* Nordberg diesels, each rated 5750 hp, in the Pedro de Valdivia power plant. The combined capacity of all ten Nordberg engines will provide over 38,000 kilowatts for nitrate production.

* * *

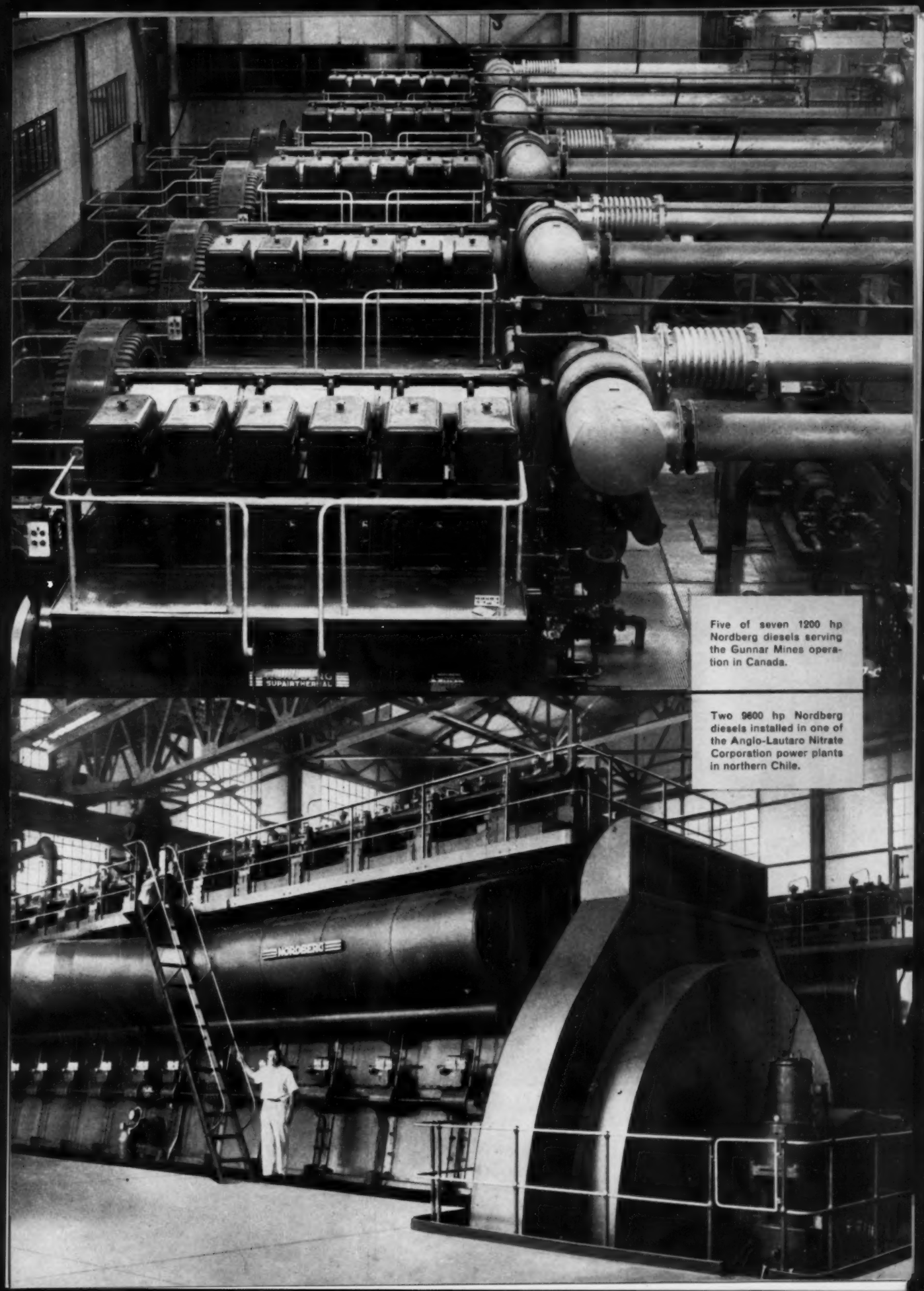
While these particular power assignments are widely separated geographically, they are striking examples of the way in which Nordberg engines produce power for the world's major industries . . . many of which are in remote, inaccessible areas where dependable operation is of prime importance.

NORDBERG MANUFACTURING COMPANY
Milwaukee 1, Wisconsin

ATLANTA • CLEVELAND • DALLAS DULUTH • HOUSTON • KANSAS CITY • MINNEAPOLIS
NEW ORLEANS • NEW YORK • ST. LOUIS • SAN FRANCISCO • TAMPA • WASHINGTON
WICHITA, KAN. • TORONTO • VANCOUVER • JOHANNESBURG • LONDON • MEXICO, D. F.

Circle No. 96 on Readers' Service Card

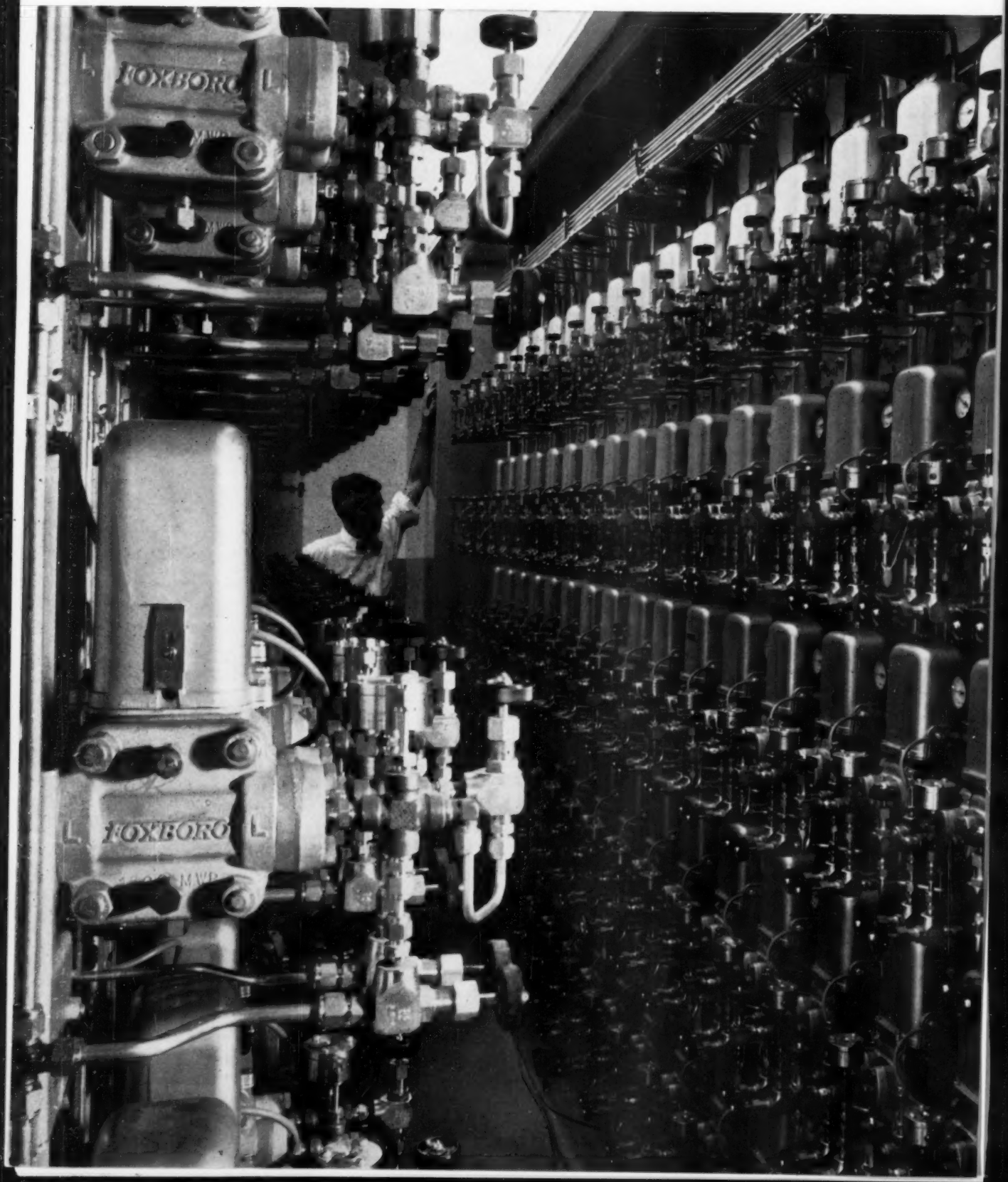
P959-R



Five of seven 1200 hp Nordberg diesels serving the Gunnar Mines operation in Canada.

Two 9600 hp Nordberg diesels installed in one of the Anglo-Lautaro Nitrate Corporation power plants in northern Chile.

high sustained accuracy of
cited at Canadian



Foxboro d/p Cell* Transmitters Atomic Research Center

"90% of our d/p Cells were still within original calibrated accuracy after a full year's operation"

Atomic Energy of Canada reports

You couldn't wish for better transmitter performance than they're getting at Atomic Energy of Canada Limited's Chalk River, Ontario, Nuclear Research Center.

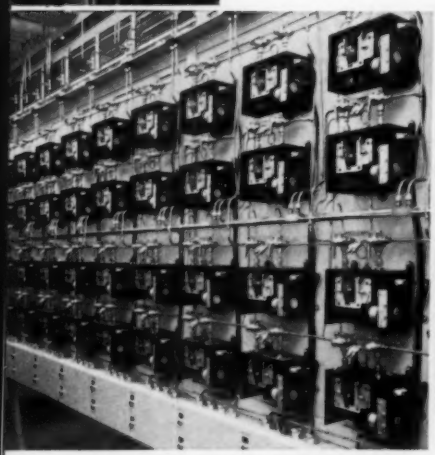
Over 200 Foxboro pneumatic differential pressure transmitters are used to measure coolant flowing through "hot" uranium rods in the core of their 200,000 kilowatt NRU Reactor. Yet, in a calibration check made after a full year's operation, less than 10% of the d/p Cells required any recalibration at all.

Accurate, dependable, stable zero — the Foxboro d/p Cell is an ideal transmitter for either nuclear or process control use. Write for Bulletin 13-11; it gives complete details. The Foxboro Company, 964 Neponset Ave., Foxboro, Massachusetts.

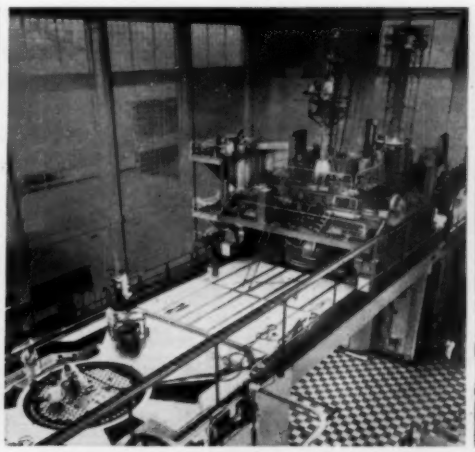
FOXBORO

REG. U. S. PAT. OFF.

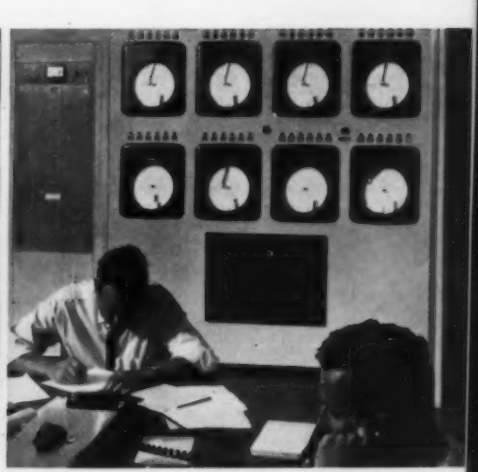
◀ **Each one of these Foxboro d/p Cell Transmitters** is connected to a uranium fuel rod in AECL's 200,000 kilowatt NRU Reactor. Holes bored in rod-ends serve as orifice plates for measuring flow of heavy water through each rod.



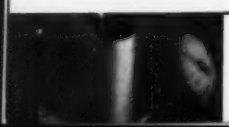
Foxboro Electro-Pneumatic Relays compare flow of water through each fuel rod with average flow of water through several rods. Relays also trigger alarms when coolant flow exceeds — or drops below — desired rate.



NRU Reactor can be refueled without shutting down. Used uranium rods are drawn up into 240-ton flask (shown at far right) — then carried across bridge for storage in water-filled handling bay.



Foxboro Multi-Record Dynalog* Electronic Recorders on Health Monitoring Panel show radiation levels at all times. NRU Reactor is used for nuclear power experiments, for fundamental research, and to produce radioactive isotopes and plutonium.



Circle No. 58 on Readers' Service Card

*Reg. U.S. Pat. Off.

FALK

A GOOD NAME IN INDUSTRY

Ask for Bulletin 7100

Ask for Bulletin 7100

147 COMBINATIONS . . . horizontal or vertical applications . . . . .

UNIT SIZE	SHAFT MOUNTED DRIVES					
	RATIOS			MOTOR MOUNT	OVERLOAD RELEASE	BACK-STOP
	4	14	24*			
107J	X	X	X	X	X	X
115J	X	X	X	X	X	X
203J	X	X	X	X	X	X
207J	X	X	X	X	X	X
215J	X	X	X	X	X	X
307J	X	X	X	X	X	X
315J	X	X	X	X	X	X
407J		X	X	X	X	X
415J		X	X	X	X	X
507J		X	X	X	X	X

½ to 125 hp. Up to 100,000 lb-in. torque *20:1 ratio for sizes 107 and 115

UNIT SIZE	FLANGE MOUNTED DRIVES					
	RATIOS				BACK-STOP	MOTOR MOUNT
	4	9	14	24*		
107J	X	X	X	X	X	X
115J	X	X	X	X	X	X
203J	X	X	X	X	X	X
207J	X	X	X	X	X	X
215J	X	X	X	X	X	X
307J	X	X	X	X	X	X
315J	X		X	X	X	X
407J			X	X	X	X
415J			X	X	X	X
507J			X	X	X	X

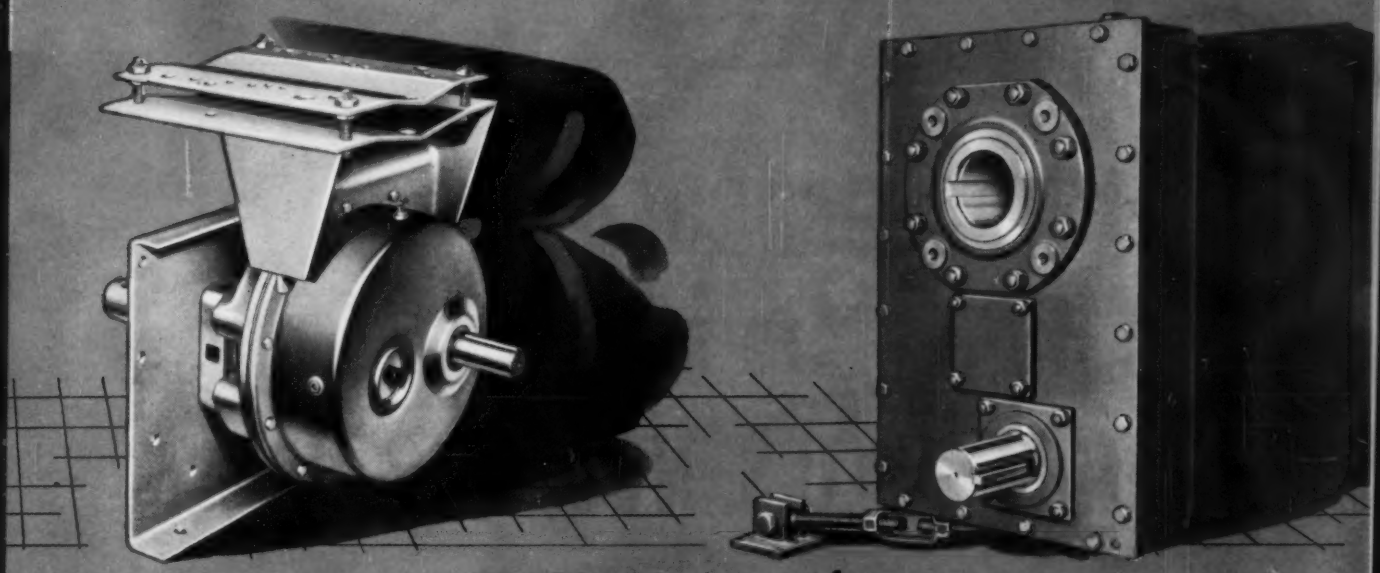
½ to 125 hp. Up to 100,000 lb-in.

***Exclusively* FALK... *Adaptability of all these three types of Falk Drives for use with Equi-Poised Motor Mount.* This feature reduces costs of engineering and constructing motor bases and foundations.**

***Exclusively* FALK... *Interchangeable rotating elements* size-for-size between Shaft and Flange Mounted Drives or Screw Conveyor Drives. This feature simplifies stocking and maintenance for large users.**

. the most complete line of SHAFT MOUNTED, FLANGE MOUNTED and SCREW CONVEYOR drives . . .

The line with the exclusive EQUI-POISED motor mount



Ask for Bulletin 7106

. . . AVAILABLE FROM STOCK

UNIT SIZE	SCREW CONVEYOR DRIVES				
	RATIOS				MOTOR MOUNT
	4	9	14	24*	
107J	X	X	X	X	X
115J	X	X	X	X	X
203J	X	X	X	X	X
207J	X	X	X	X	X
215J	X	X	X	X	X
307J	X	X	X	X	X
315J	X		X	X	X
407J			X	X	X
415J					
507J					

½ to 40 hp. Up to 44,000 lb-in. torque

Exclusively **FALK...*Single helical gears* used in *all* sizes and types—they provide maximum (98½%) efficiency per gear mesh.**

FALK is a registered trademark

New 2 LARGER SIZES OF SHAFT MOUNTED DRIVES—415-507

Falk-designed and Falk-built for higher torque requirements, these all-steel, *helical* gear reducers are available in Shaft and Flange Mounted Drive design.

TWO RATIOS, 15:1 and 25:1
HORSEPOWER RATINGS TO 125
TORQUE RATINGS TO 100,000 LB-IN.

Ask for **Bulletin 7100.1 (Shaft and Flange Mounted Drives) or for Bulletin 7106.1 (Screw Conveyor Drives).**

THE FALK CORPORATION
MILWAUKEE 1, WISCONSIN

Manufacturers of Quality Gear Drives and Flexible Shaft Couplings

Representatives and Distributors in most principal cities

A POINT TO PONDER..when you need gear drives or shaft couplings of "FALK OR EQUAL" quality, where but from Falk can you get the "OR EQUAL"?

Circle No. 33 on Readers' Service Card

Pipe being ultrasonically tested as required by Military Specification MIL-T-18063A (Ships).

SIZE RANGE

Diameter 8" through 28" O.D.
Wall ½" to 4"
Length up to 22 feet
Types of Stainless:
Austenitic grades, including E.L.C.

again "HYDROFORGED" fine-grain stainless piping specified for U.S. NUCLEAR NAVY

—INSTALLED IN NEW U.S.S. ENTERPRISE

U.S. NAVY SERVICE APPLICATIONS INCLUDE: Pipe for valve operating system reservoirs and primary water preheaters.

Primary coolant piping for nuclear submarines and surface ships.

Seamless welding fitting stock for large diameter reactor piping systems for submarines and surface ships.

Demineralizer shells.

Operating conditions in these services are in the range of 700° F. and 2,500 PSI.

THE PROCESS: The starting point is a high quality machined hollow billet, made centrifugally, which is cold expanded by hydrostatic pressures up to 50,000 PSI in specially designed massive metal dies. After "hydroforging," the pipe is given a recrystallizing anneal which results in the grain refinement characteristic of wrought stainless steel.

THE PRODUCT: After final machining of the O.D. and I.D. surfaces to 125 microinch finish, the pipe is subjected to all the testing requirements of Military Specification MIL-T-18063A (Ships) which covers seamless austenitic steel tubes and pipe intended for radioactive system services. This specification includes: chemical analysis, tensile properties (for Type 304 stainless steel—75,000 PSI minimum tensile strength, 30,000 PSI minimum yield strength, 35% minimum elongation), expanding and flattening tests, hydrostatic pressure test, intergranular corrosion test, macro-etch, ultrasonic and liquid penetrant examination.

The U.S.S. Enterprise, our first nuclear-powered super aircraft carrier, can cruise at great speed and for almost unlimited time and distances without refueling. The Enterprise, built by Newport News Shipbuilding and Dry Dock Co., ushers in a new age of mobility and power for air and surface warfare at sea. At left, the Skipjack, nuclear-powered and with revolutionary blimp-shaped hull, is the fastest of the A-Subs. Both vessels utilize hydroforged fine-grain stainless pipe supplied by United States Pipe and Foundry Company.

UNITED STATES PIPE & FOUNDRY CO.

Steel and Tubes Division

STEEL & TUBES U.S. PIPE DIVISION

BURLINGTON, NEW JERSEY

SALES OFFICES: BURLINGTON, HARTFORD, BIRMINGHAM, CHICAGO, CLEVELAND, DALLAS, LOS ANGELES, NEW YORK, PITTSBURGH, SAN FRANCISCO

N-A-XTRA 100

NOW CODE-APPROVED FOR DESIGN OF UNFIRED PRESSURE VESSELS

A.S.M.E. CASE NO. 1297. Code approval granted by the American Society of Mechanical Engineers now makes N-A-XTRA 100 steel the logical material for use in unfired pressure vessels. This high-strength steel is fully quenched and tempered—permits greater savings and efficiency in fabrication, erection, handling, welding and shipping. Its high strength/weight ratio cuts dead weight. It cold forms readily, welds under constrained conditions without underbead cracking. These benefits are the result of the outstanding characteristics of N-A-XTRA 100 . . .

MECHANICAL PROPERTIES

Tensile Strength, psi	115/135,000
Yield Strength, psi	100,000 min.
Notch toughness at exceptionally low temperatures	

CHEMICAL COMPOSITION

Carbon	.15/.20
Manganese	.80/1.10
Phosphorus, max.	.035
Sulphur, max.	.040
Silicon	.50/.80
Chromium	.50/.80
Molybdenum	.18/.28
Zirconium	.05/.15

Make a note now. For larger, stronger or lighter pressure vessels —from mobile tankers to stationary storage tanks—specify code-approved N-A-XTRA 100.

Great Lakes Steel Corporation
Product Development, Dept. ME-6
P. O. Box 7310
Detroit 2, Michigan

Please send me complete copy of the A.S.M.E. Code Case No. 1297.

NAME _____

FIRM _____

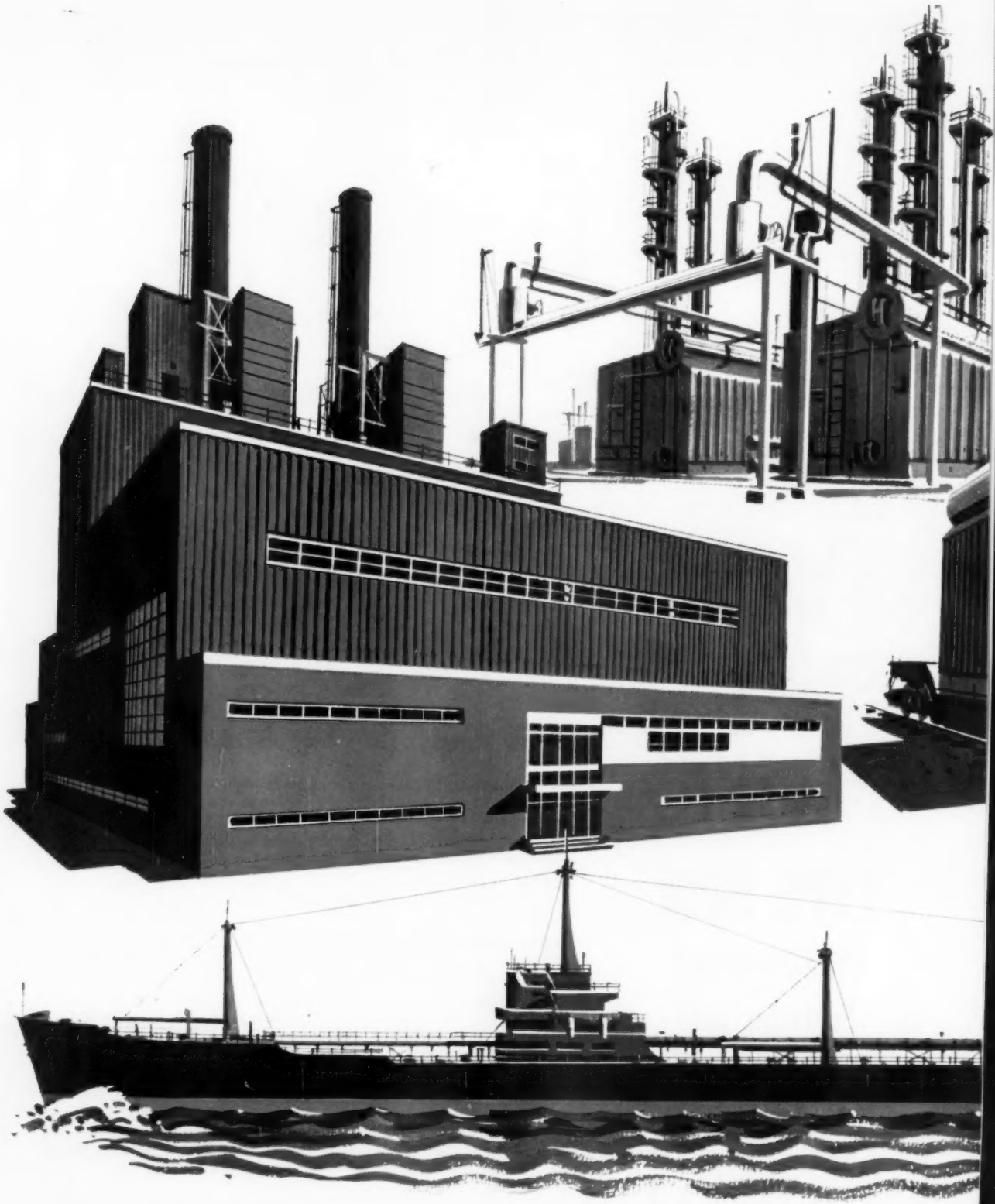
ADDRESS _____

CITY _____ ZONE _____ STATE _____

GREAT LAKES STEEL
DETROIT 29, MICHIGAN

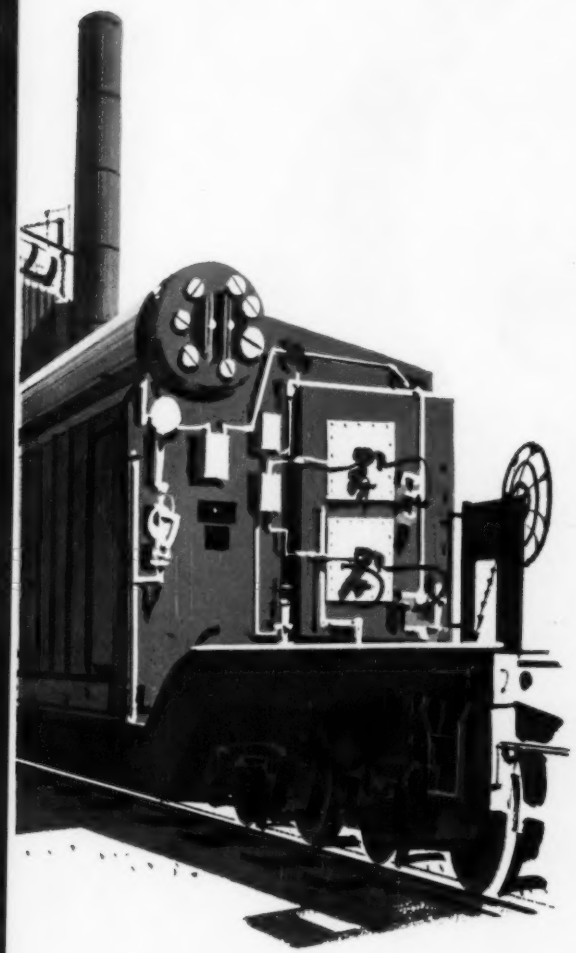
Great Lakes Steel is a division of
NATIONAL STEEL CORPORATION

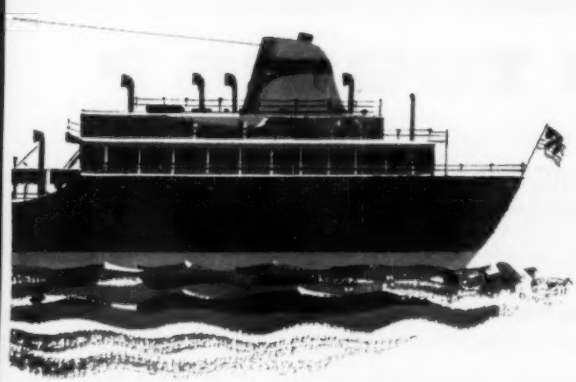
Circle No. 152 on Readers' Service Card



POWER PLANT PRODUCTS HEAT ENGINEERED BY FOSTER WHEELER:

Central Station and Industrial Steam Generators • Steam Condensers and Pumps • Cooling Towers
Pulverized Fuel Systems • Feedwater Heaters • Packaged Steam Generators • Nuclear Components





A broader power base to serve you

Through contributions in every field where steam power is used, Foster Wheeler has accumulated knowledge and experience that are yours today in all Foster Wheeler equipment and services.

FW-built steam generating units are identified with the central stations of leading U.S. utilities. Foster Wheeler has designed, engineered and built more nuclear steam generators and pressurizers than any other manufacturer in the world. And FW is the leading U.S. supplier of marine steam generating equipment.

In factories, oil refineries, chemical plants and every other type of installation requiring useful heat, Foster Wheeler is in the top rank of companies supplying heat transfer and steam power equipment.

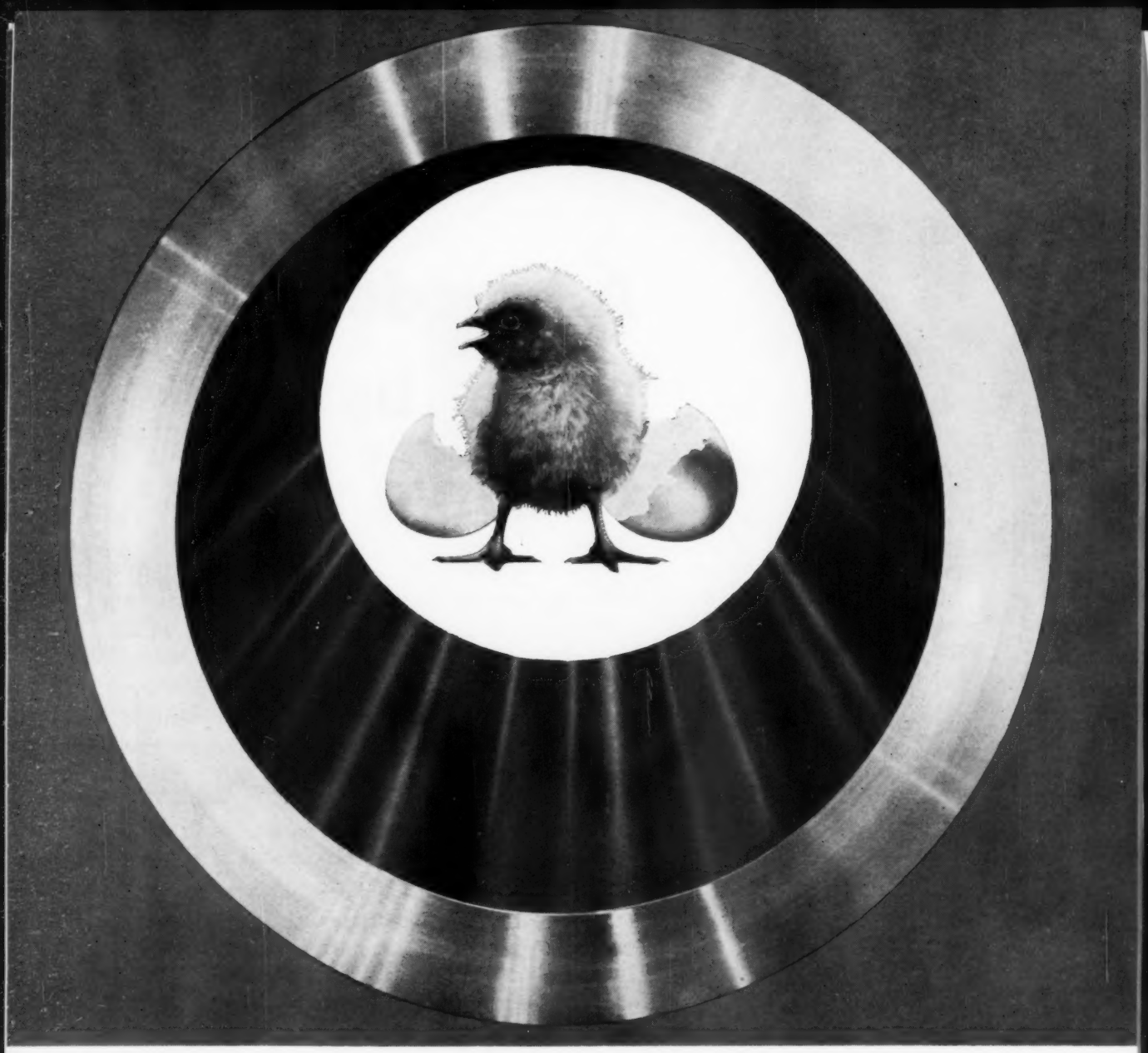
When such equipment becomes your need, assure yourself of the benefit of FW's broader experience with the *full range* of steam producing components.

FW engineers, fabricates and erects them all: utility and industrial steam generators, feedwater heaters, steam condensers, evaporators, pulverizers, cooling towers, specialized pressure vessels and industrial processing plants.
Foster Wheeler Corporation, 666 Fifth Avenue, New York 19, N.Y.

FOSTER FW WHEELER

NEW YORK TORONTO LONDON PARIS MILAN TOKYO

Circle No. 57 on Readers' Service Card



WHAT'S NEW IN TUBING?

Here's another ACIPCO "first"... ACIPCO CERAM-SPUN®, the ceramic mold process* that offers greater versatility in design, new concepts in economy.

WHAT THESE ADVANTAGES MEAN TO YOU! ACIPCO is not limited by equipment sizes. Now, for the first time, you can order the exact tube O.D. you need... from 2.25" to 50". As-cast lengths can vary from 4 feet to 20 feet, longer lengths are made by welding; and wall thicknesses range from .25" to 8". Furthermore, these tubes can be furnished with the exact combination of physical, chemical, and metallurgical properties required by your specifications.

THE RESULT: YOU SAVE MORE! No more unnecessary metal waste or excessive machine charges.

Too, ACIPCO's complete "under one roof" operations — including heat treating, machining and welding — eliminate the delays and additional high costs often involved in buying from multiple sources. Before you order another steel tube... first investigate the many advantages ACIPCO offers. Contact ACIPCO STEEL PRODUCTS, Division of American Cast Iron Pipe Company, Birmingham 2, Alabama.

*Patent applied for

ACIPCO CERAM-SPUN®
STEEL TUBING

Circle No. 8 on Readers' Service Card

It's all there, every detail sharp and clear, in RECORDAK precision 35mm microfilm images

There's more to these RECORDAK pictures than meets the eye!

RECORDAK precision 35mm microfilm images *more than meet DOD requirements*—give a minimum of 120 lines per mm resolution at 30-to-1 reduction ratio.

Look closely at some RECORDAK microfilm images in a film reader. See how every detail is sharp and clear . . . how the backgrounds are remarkably uniform, even though the pictures you're looking at were made from drawings and prints of every type and age.

How do these RECORDAK pictures come out so well?

First, the negatives are made on RECORDAK Micro-File Film with RECORDAK Precision Microfilming equipment. Carefully controlled exposure techniques assure uniform backgrounds and contrast. The exposed film then is developed, according to the most up-to-date scientific standards.

Your staff can easily be trained in the use of RECORDAK Micro-File equipment especially calibrated to produce images which meet DOD requirements.

This is important, for your success with an automated engineering drawing program depends *mainly* on the quality of the pictures you use, and on the quality of the prints you can make from them.

Free booklet goes into more details on precision microfilming available through Recordak or a Microfilming Dealer of Recordak.

MAIL COUPON TODAY

RECORDAK CORPORATION LL-4
415 Madison Ave., New York 17, N.Y.

Send booklet describing RECORDAK Engineering Drawing System and name of nearest Microfilming Dealer of Recordak.

Name_____

Company_____ Position_____

Address_____

City_____ Zone____ State____

RECORDAK®

(Subsidiary of Eastman Kodak Company)

originator of modern microfilming

—now in its 33rd year

IN CANADA contact Recordak of Canada Ltd., Toronto

Circle No. 110 on Readers' Service Card

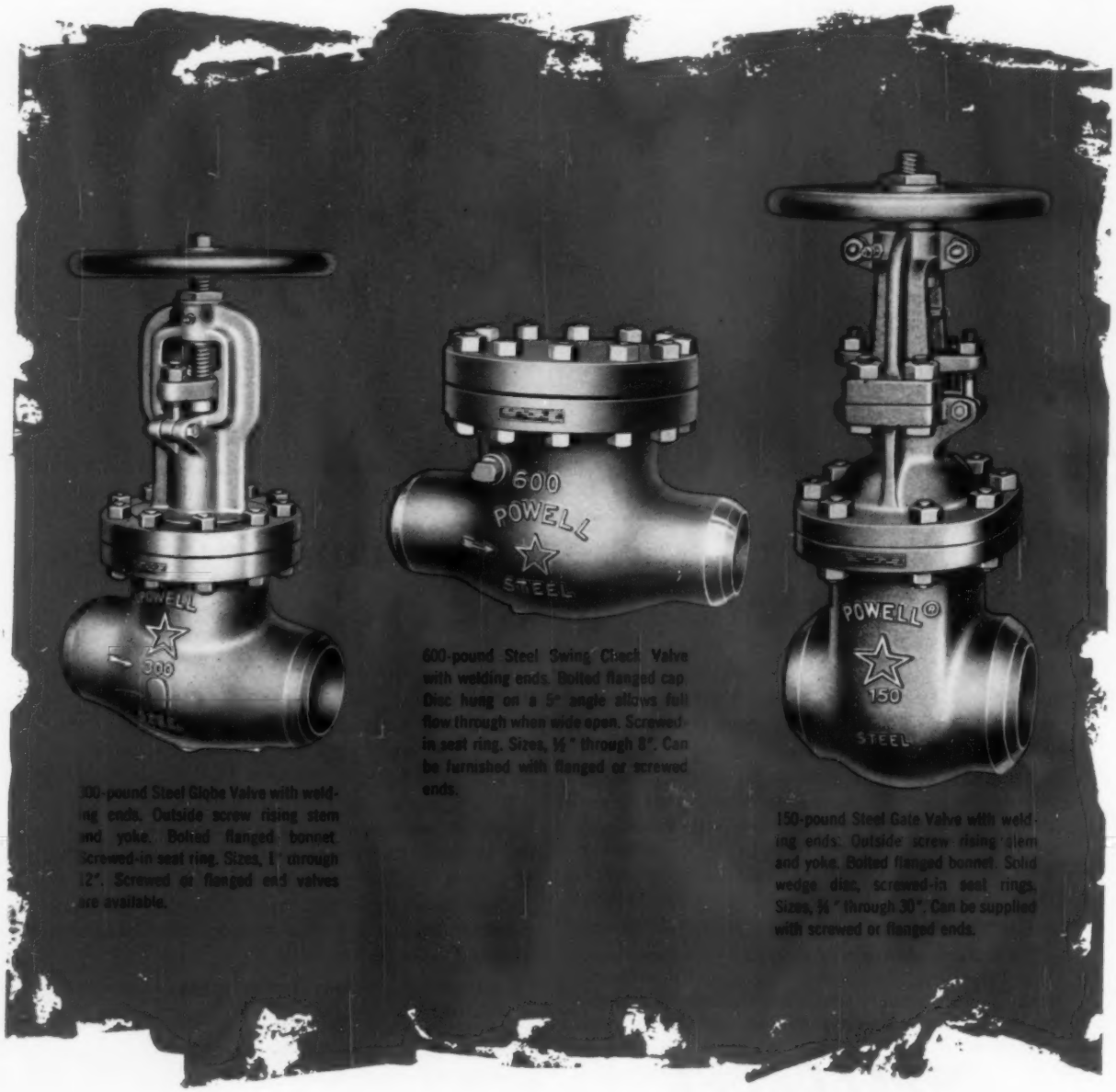
POWELL PERFORMANCE PAYS OFF

Any way you look at it, Powell Valve performance really pays off—performance that's conclusively proven in power plants everywhere.

You can find at Powell any type of valve you may need to handle water, oil, gas, air, steam, corrosive fluids, even molten metals and other radioactive materials used in atomic power plants.

Consequently, Powell can help simplify flow control projects and contribute real savings in time and money. For example, in describing a modern 125,000-KW steam-electric generating plant, a leading authority recently listed some 80 areas requiring a total of over 1300 valves . . . Powell could have supplied almost every one.

Learn how this Powell performance can mean a real payoff for you. Contact your nearby Powell Valve distributor, or write direct.



300-pound Steel Globe Valve with welding ends. Outside screw rising stem and yoke. Bolted flanged bonnet. Screwed-in seat ring. Sizes, 1" through 12". Screwed or flanged end valves are available.

600-pound Steel Swing Check Valve with welding ends. Bolted flanged cap. Disc hung on a 5° angle allows full flow through when wide open. Screwed-in seat ring. Sizes, ⅛" through 8". Can be furnished with flanged or screwed ends.

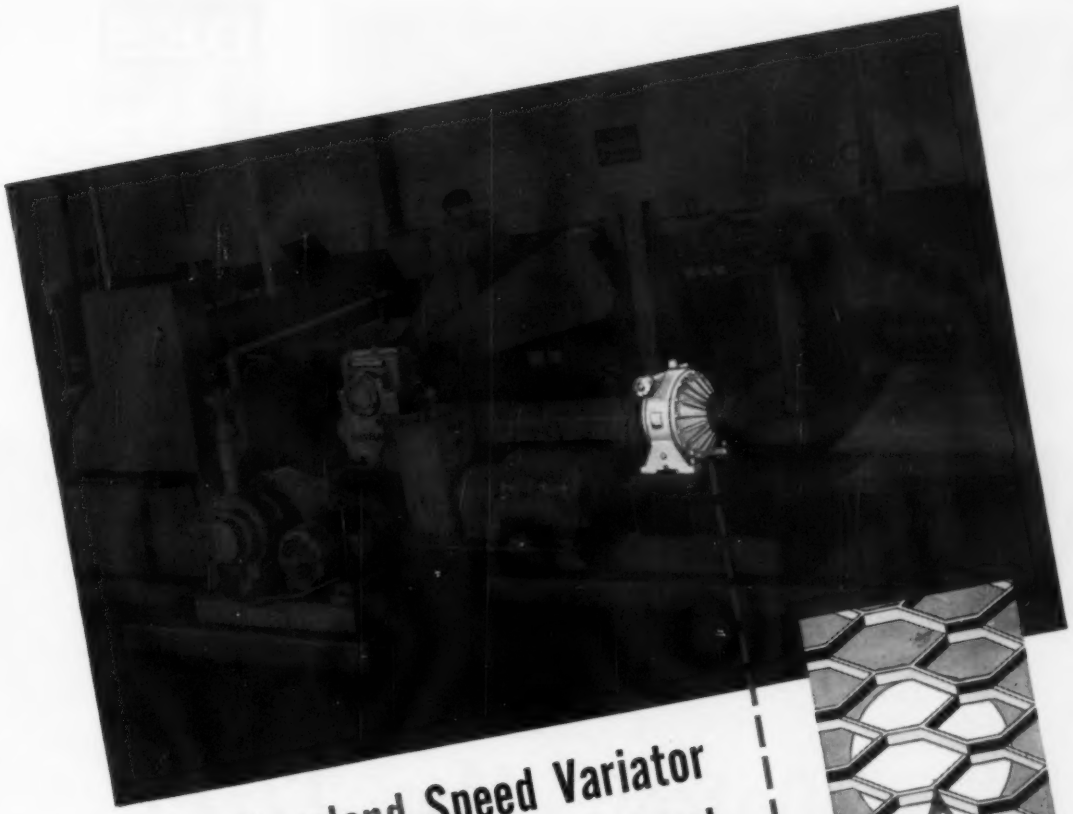
150-pound Steel Gate Valve with welding ends. Outside screw rising stem and yoke. Bolted flanged bonnet. Solid wedge disc, screwed-in seat rings. Sizes, ¼" through 30". Can be supplied with screwed or flanged ends.

115th year of manufacturing industrial valves for the free world

POWELL STEEL VALVES

THE WM. POWELL COMPANY CINCINNATI 22, OHIO

Circle No. 106 on Readers' Service Card



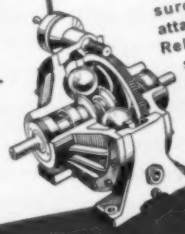
a *rugged* Cleveland Speed Variator keeps Steel Lath quality at top level

Playing an important role in the production of perforated metal lath is a heavy-duty Cleveland Speed Variator. This novel lathing "keys for keeps" because applied plaster is automatically guided into a positive locked-in position by the precise twist *engineered into the work.

Driving the lath machine's leveller is the job assigned to the Speed Variator. It's a mighty important function because leveller speed has to be in absolute synchronization with expander speed. If not, lath will buckle or expand too much. Then lath is rejected—profits drop.

With their Cleveland Speed Variator, the lath producer is able to maintain set speeds—without *any* variance. Changing speeds, if desired, is merely a simple twist-of-the-wrist.

Wherever there's a need for industrial speed variation—there's a Cleveland to handle the job smoother, quieter, more efficiently. Write for your free copy of Variator Bulletin K-200—it gives the complete engineering story.



HOW IT WORKS

Power is transmitted from input shaft to output shaft through alloy steel driving balls which are in pressure contact with discs attached to the two shafts. Relative speeds of the shafts are adjusted by changing the positioning of the axles on which the balls rotate (see cutaway view.)

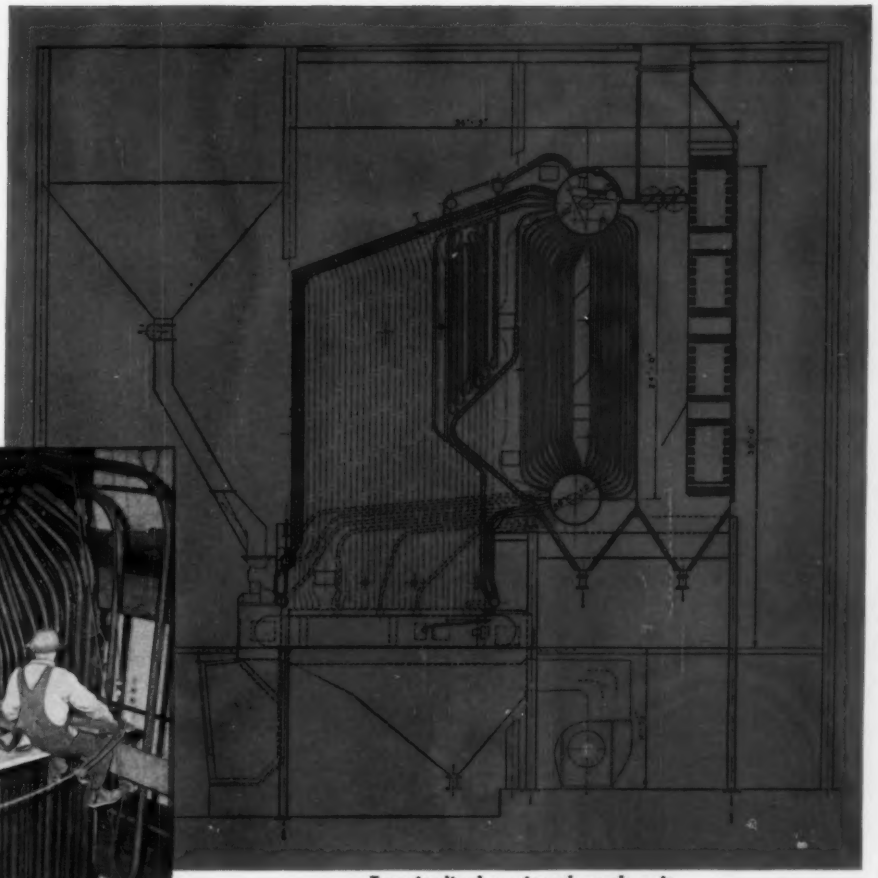
Cleveland Worm & Gear Division
Eaton Manufacturing Company
3264 East 80th Street • Cleveland 4, Ohio

EATON

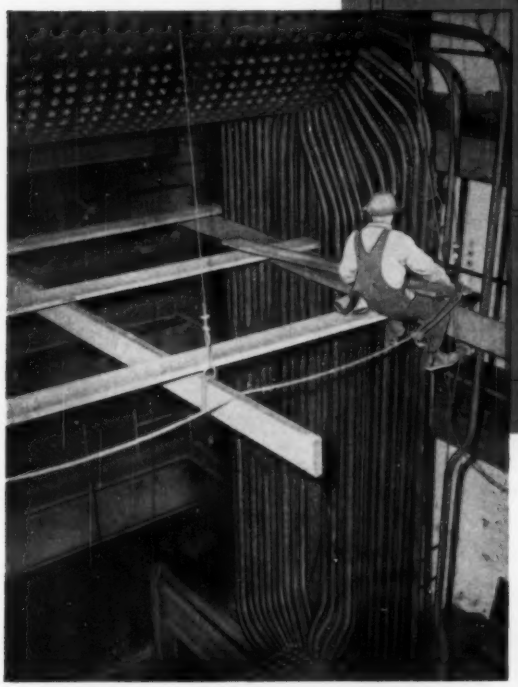
CLEVELAND SPEED VARIATOR

Circle No. 37 on Readers' Service Card

Union Starch Installs a Modern Coal Fired Steam Generator



Longitudinal section through unit.



Tubes being installed in steam and water drums.

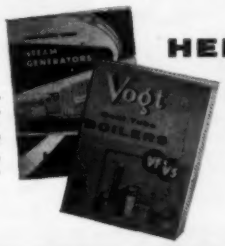
PROJECT BY
ROGERS SCHMIDT
ENGINEERING CO.
ST. LOUIS, MO.

This 125,000 pounds per hour capacity Vogt Steam Generator, especially designed to burn bituminous coal, serves the Granite City, Illinois plant of the Union Starch and Refining Company. The unit operates at 475 lbs. pressure and delivers steam at 750°F. total temperature. It has water cooled front, sides and roof of furnace and employs a spreader type coal stoker.

Vogt offers a complete line of custom built and package type steam generators for power, processing and heating. Bulletins are available upon request.

Vogt

For Custom Installation Bulletin VF-VS-2 • Package Unit Bulletin PSG-3, address Dept. 24A-BM.

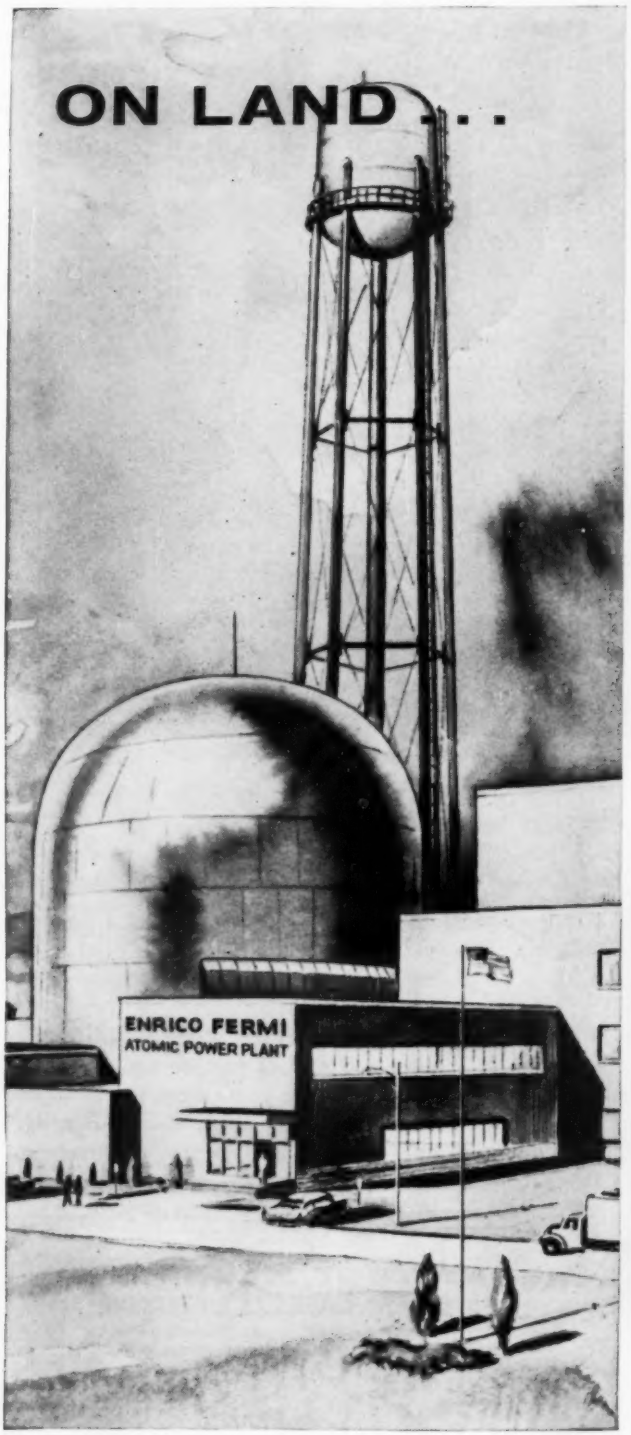


HENRY VOGT MACHINE CO.
P.O. BOX 1918, LOUISVILLE 1, KENTUCKY
SALES OFFICES: New York, Chicago, Cleveland, Dallas, Camden, N. J., Los Angeles, St. Louis, Charleston, W. Va.

For Direct Long Distance to Louisville Dial: 502 ME 4-9411

STEAM GENERATORS

Circle No. 132 on Readers' Service Card

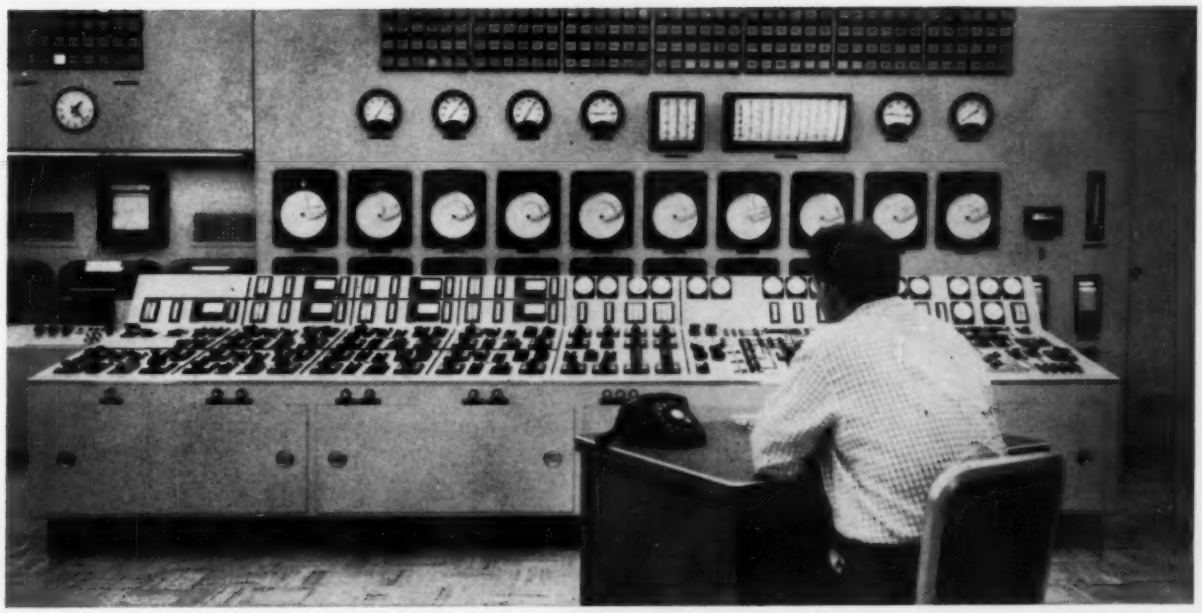


At the Enrico Fermi Atomic Power Plant, instruments and controls for both the "fast neutron breeder" reactor and the steam plant which it will "fire" are being furnished by Bailey.

Many of the new ships such as this super-carrier, USS Ranger, operate their boilers by Bailey Meter Control. Cargo ships, tankers, and passenger liners as well as Naval ships improve the economy and safety of their steam plants thru use of Bailey controls.

At the Thomas H. Allen Electric Generating Station of the City of Memphis, Tenn., Bailey operating indicators and controls for combustion, feed water, and steam temperature are centralized on the mechanical bench-board directly ahead, while the operating records which reflect trends are mounted on the vertical boards. A Bailey METROTYPE Information System, center left in the photo, scans, monitors, and logs functions usually assigned to strip-chart recorders.

IT'S BAILEY. . .



for the latest and safest instruments and controls for nuclear and conventional power plants!

Many of the power plants of the future will have controls and instruments designed and built by Bailey. There are two reasons: Bailey's continuing research and development toward the latest equipment for industry's needs; Bailey's 40-year association with the hardware and economic requirements of the industry.

If you are planning new or improved power plant facilities, call on Bailey engineers to assure that your system will have the *proper balance both as to economics and needs . . . that there will not be the unnecessary expense of over-instrumentation or control . . . nor the duplication of equipment functions.*

Call on Bailey for primary sensing devices, indicators, loggers, control units, panels, data handling equipment, computers for performance analysis, and supervisory controls. You'll find designs ranging from conventional to the most sophisticated . . . mechanical, pneumatic, electric and electronic, including solid state.

There's a Bailey District Office or Resident Engineer close to you. Check your phone book, or write direct.

A144-2

Instruments and controls for power and process

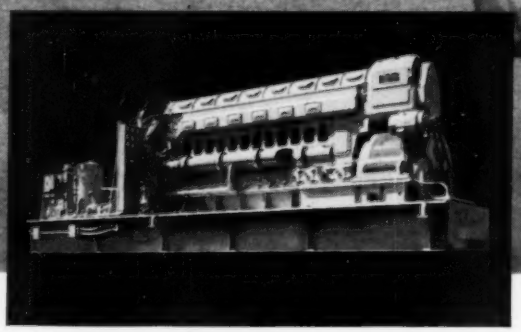
BAILEY METER COMPANY

1026 IVANHOE ROAD • CLEVELAND 10, OHIO

In Canada—Bailey Meter Company Limited, Montreal

Circle No. 19 on Readers' Service Card

NOW! FULL POWER IS 15 SECONDS FAST!



Solve peak-load and standby problems! F-M's exclusive O-P Diesel Generating Units provide *full* power in 15 short seconds . . . *from a cold start!* They need no spinning reserve. Use no power till you use them! The reason? Our exclusive O-P (Opposed-Piston) design. Two pistons in one cylinder function from a *single* combustion. This minimizes *vibration* . . . produces fine *balance, smooth* power to peak the generator—in just 15 seconds! F-M Opposed-Piston Diesel Generating Units are available with automatic or manual controls. Produce up to 2500 kw per unit. They may be linked in multiple units for peaking, standby duty . . . or dead load pickup! You can't buy better—or more economically.

For full details or custom specifications, write today to: **Mr. S. K. Howard; Diesel Division; Fairbanks, Morse & Co.; Beloit, Wisconsin.**

FAIRBANKS MORSE

A MAJOR INDUSTRIAL COMPONENT OF

FAIRBANKS WHITNEY

Circle No. 52 on Readers' Service Card

Now it's much easier to solve your pipe motion problems

. . . with new Flexonics EXPANSION JOINT ENGINEERING GUIDE

New convenient way to solve pipe motion problems! Flexonics Expansion Joint Engineering Guide – just off the press – contains a wealth of vital information in easy-to-read, easy-to-use form. 42 pages of calculations, tables, anchoring and guiding data. Every piping system designer needs this new book. Mail the coupon for your FREE copy!

EJ-279

Flexonics

FLEXONICS CORPORATION • BARTLETT, ILLINOIS
In Canada: Flexonics Corporation of Canada, Ltd., Brampton, Ontario

METAL and SYNTHETIC HOSE
EXPANSION JOINTS
BELLOWS • SPECIAL TUBULAR ASSEMBLIES

SUBSIDIARY OF CALUMET & HECLA, INC.

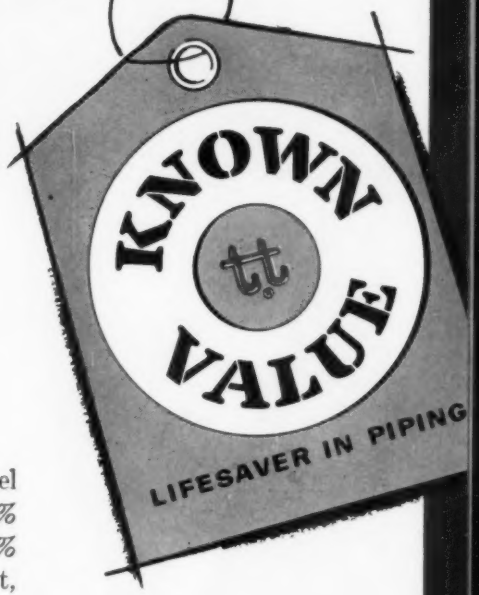
ATTACH TO YOUR LETTERHEAD—MAIL TODAY!

Flexonics Corporation
348 E. Devon Avenue
Bartlett, Illinois

Please send my free copy of the new Flexonics Engineering Guide on Expansion Joints, Expansion Compensators, and Pipe Guides and Supports.

Circle No. 55 on Readers' Service Card

YOU SAVE MOST WITH LIGHTWEIGHT PIPING WHEN YOU SAVE WITH TUBE-TURN® WELDING FITTINGS AND FLANGES



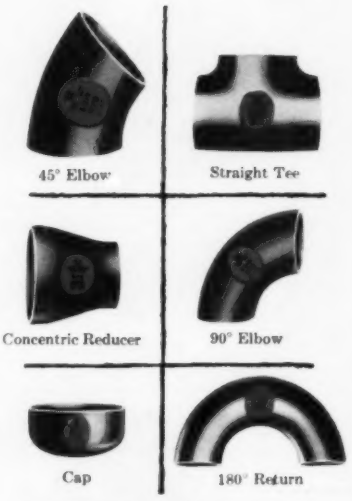
Process piping systems designed with new lightweight carbon steel piping have scored impressive cost reductions. Users report 30% savings in pipe costs alone. Lightweight piping weighs 20% to 50% less than standard wall carbon steel pipe . . . it's easier to handle, cut, align, weld and support . . . can be installed 25% faster. Lightweight piping also provides greater flow area, saves on pumping costs.

Tube Turns paced this piping progress by developing the first complete line of lightweight fittings and taper face flanges. Forged from seamless carbon steel pipe, TUBE-TURN lightweight fittings feature uniform wall thickness and true circularity . . . assures perfect pipe-to-fitting alignment, permits field cutting of odd angles, too.

TUBE-TURN 125 lb. lightweight forged steel taper face flanges provide three times the sealing capacity of ordinary flanges . . . eliminates the hazards of breaking cast iron or semi-steel valves, fittings, and equipment. TUBE-TURN lightweight taper face flanges cost less, weigh less, and take less storage space.

If you are planning lightweight piping systems, be sure you specify TUBE-TURN lightweight piping components for maximum savings, performance and dependability. Look for the famous "tt" trademark when you buy. It's your guarantee of quality . . . the mark of *known value*. Write today for Bulletin TT942D205. TUBE TURNS, Louisville 1, Kentucky.

"TUBE-TURN" and "tt" Reg. U.S. Pat. Off.



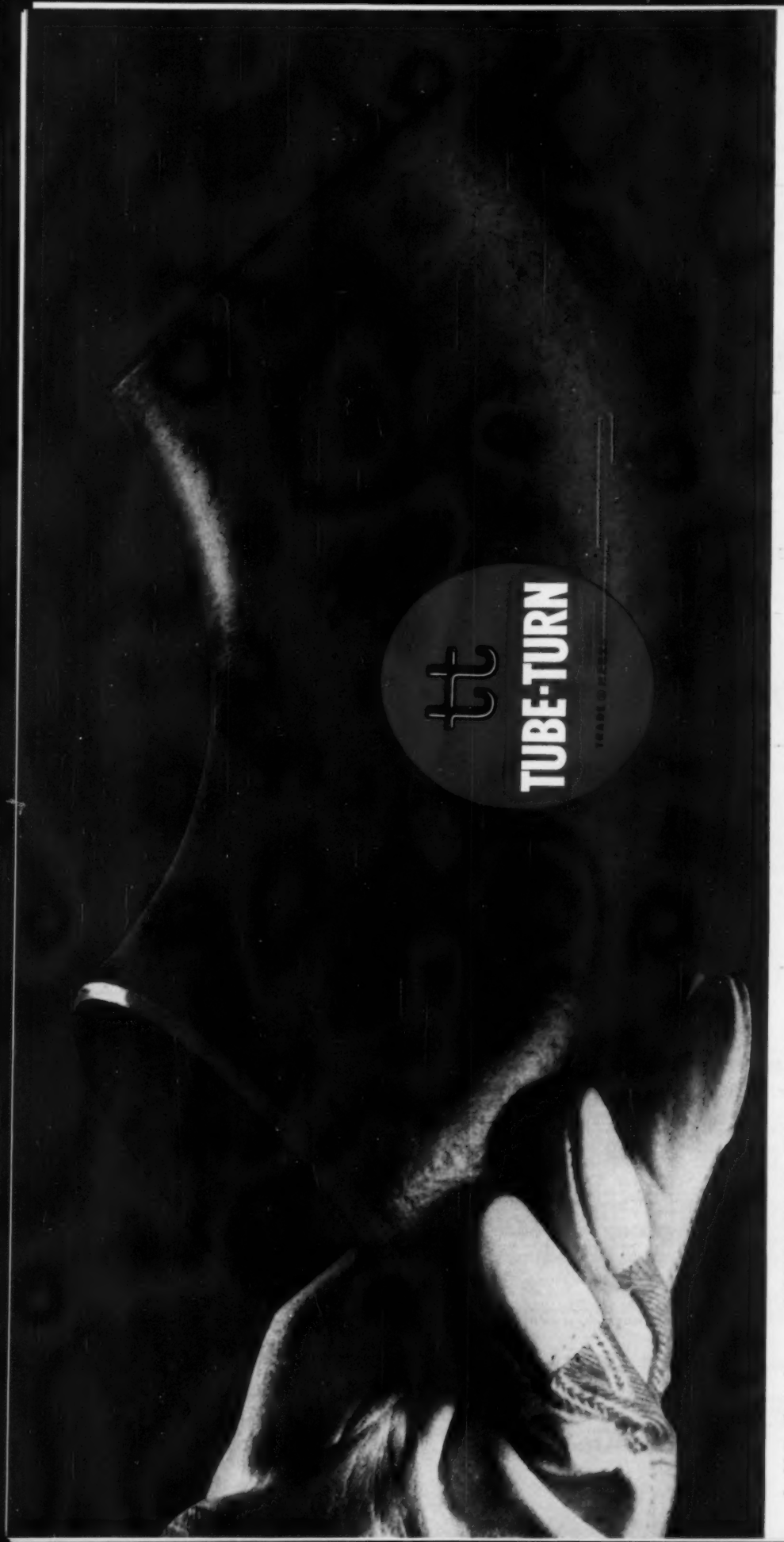
TUBE-TURN Light Weight Fittings are available in sizes ½" through 24" —in schedule 10 and API-5L wall thicknesses.

TUBE-TURN 125 lb. Light Weight Taper Face Welding Neck Flanges are available in sizes of 2" through 24".

TUBE TURNS

Division of CHEMETRON *Corporation*

Circle No. 127 on Readers' Service Card



KNOWN VALUE

LIFESAVER For The Men Who Design Piping

Tube Turns offers not only the most complete line of properly engineered lightweight piping components for utmost flexibility in planning any piping installation, but a wealth of technical data and able engineering assistance without counterpart anywhere in the world. Standardizing on TUBE-TURN piping components saves time and trouble.

KNOWN VALUE

LIFESAVER For The Men Who Buy Piping

The world's most complete line of lightweight fittings and taper face flanges permits every specification to be met without compromise or delay. A fully responsible Tube Turns Distributor is as near as your telephone to give prompt delivery of *all* your needs from *one* source on a *single* order. Saves time, paperwork, multiple checking, piecemeal deliveries and the inevitable problems of divided responsibility. You *save* money when you standardize on TUBE-TURN piping components!

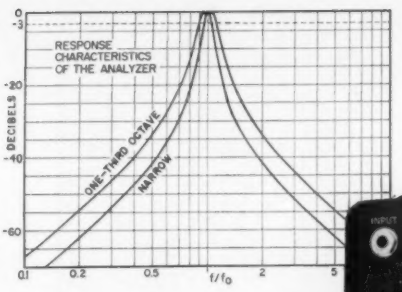
KNOWN VALUE

LIFESAVER For The Men Who Install Piping

Time is money in the assembly of a welding piping system. TUBE-TURN lightweight piping components do not require remanufacture or compromises . . . or the delays that result from rejections. They are uniform, precision-engineered for easy, time-saving installation. And you can put them in and *forget* them because they *are* dependable. TUBE-TURN piping components cost less because they save more in every way!

TUBE-TURN Lightweight Fittings And Taper Face Flanges Are Stocked By And Sold Exclusively Through Authorized Distributors.

Bandwidth at 3-db points:
NARROW: 8% of center frequency
ONE-THIRD OCTAVE: 23% of center frequency

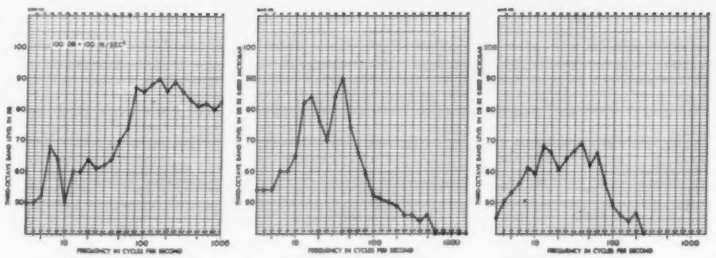


This Sound and Vibration Analyzer . . .

- **Frequency range:** continuously tunable from 2.5c to 25 kc in four ranges.
- **Two constant-percentage bandwidths:** "narrow", and "one-third octave" (see plot) and an "all-pass" position for measurement of overall level.
- **Input voltage range:** 100 μv to 30v.
- **Direct reading** in sound-pressure level, one-third octave-band level, or input volts.
- **Battery-operated** for field use
- **Price . . . $1060.**

Helped Solve This Problem

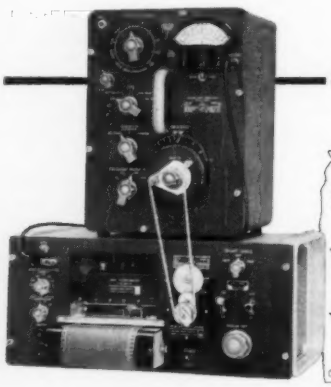
These third-octave measurements were made in an office that was troubled by low-frequency noise. The culprit — a nearby air compressor. Vibration measurements at the compressor indicated that the trouble was not caused by structure-born vibrations. The offender proved to be the pulsations of air at the compressor's intake. Corrective measures were taken, and the resulting sound spectrum in the office was considerably improved. These measurements were made with the 1554-A Sound and Vibration Analyzer, an appropriate transducer, and a pre-amplifier with good low-frequency response.



Vibration spectrum of compressor

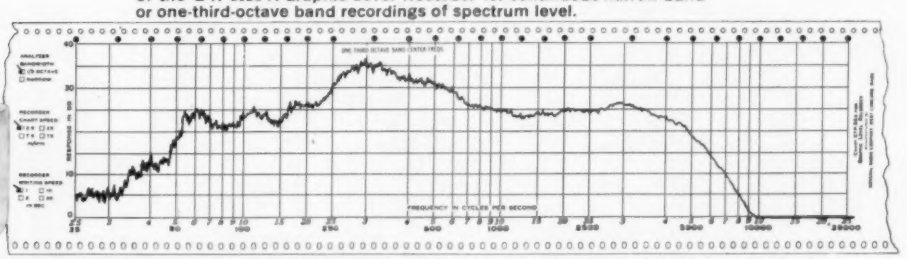
"Before" corrective measures — office sound spectrum

"After" corrective measures — office sound spectrum



SPECTRUM ANALYSIS with the Graphic Level Recorder

Sound and Vibration Analyzer is conveniently coupled to the drive unit of the G-R 1521-A Graphic-Level Recorder for continuous narrow-band or one-third-octave band recordings of spectrum level.



Shown is response of loudspeaker excited by pink noise with Analyzer set for one-third-octave mode.

Write For Complete Information

GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS

NEW YORK, WOrth 4-2722 NEW JERSEY, Ridgefield, WHitney 3-3140	CHICAGO Oak Park Village 8-9400	PHILADELPHIA Abington HAncock 4-7419	WASHINGTON, D.C. Silver Spring JUniper 5-1088	SAN FRANCISCO Los Altos WHitecliff 8-8233	LOS ANGELES Los Angeles HOllywood 9-6201	IN CANADA Toronto CHerry 6-2171

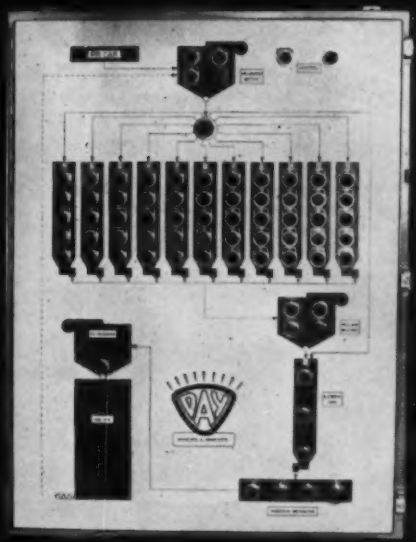
Circle No. 69 on Readers' Service Card

High density pneumatic conveying system for unloading polyethylene pellets from railcar. After piping connections are made, dual-purpose DAY "RJ" receiver, shown right in photo, "pulls" product from railcar and "pushes" it to storage tanks or manufacturing process.

PUSH A BUTTON

START

UNLOAD A RAILCAR



DAY Control panel — your most efficient link between railcar and plant, storage or process.

Save manpower, time and money unloading railcars with DAY *air-line* pneumatic conveying systems. They provide a sanitary, low cost way to unload, transport in-plant, mix, dry, cool or load any type of dry material. DAY *air-line* pneumatic conveying systems are pneumatically conveying close to 200 different products. Take advantage of this DAY experience. Discuss your pneumatic conveying and plant storage equipment requirements with DAY. Only DAY offers a complete service, including: *engineering, fabricating* and *installation* of *everything* (including bulk storage tanks) needed for efficient, economical systems.

FREE bulletin describes all types of pneumatic conveying systems. It tells how you can make substantial savings 9 ways and improve plant efficiency 6 ways with DAY *air-line* pneumatic conveying systems.

DAY SINCE 1881

equipment only or a complete system

CLIP AND MAIL COUPON TODAY

The DAY Company

876 Third Ave. N.E., Minneapolis 13, Minn.

In CANADA
The DAY Company of Canada, Ltd.
15 Brydon Dr., Rexdale (Toronto) Ontario

Please:

☐ Send Bulletin M-588 (Pneumatic Conveying Systems)

☐ Send Bulletin 574 (Tanks for Bulk Storage)

☐ Have DAY Representative Contact Me

NAME_____

COMPANY NAME_____

ADDRESS_____

CITY_____ STATE_____

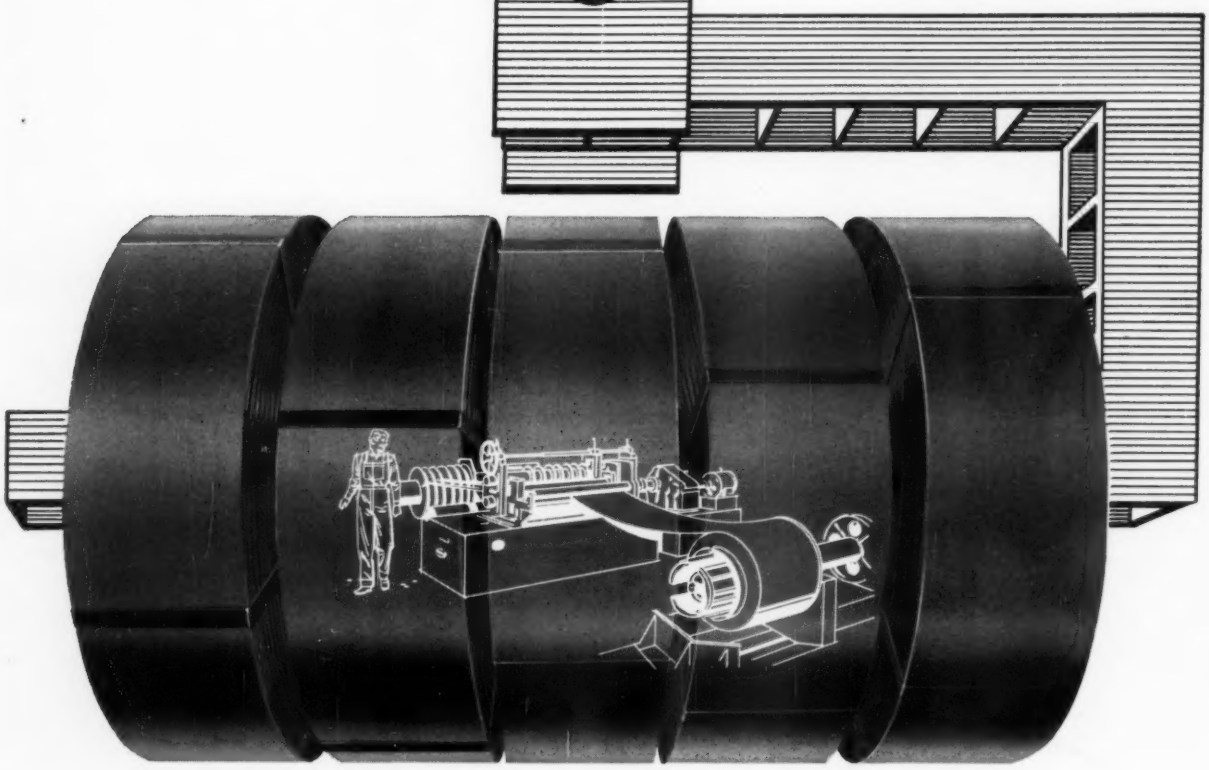
Circle No. 41 on Readers' Service Card

YODER Rotary Slitting Lines Produce the Strip Widths You Need!

Investigate the many advantages of YODER-engineered Slitter Installations. Write today for this comprehensive, 80 page YODER Slitter Manual . . . it's yours for the asking!

THE YODER COMPANY
5549 Walworth Avenue • Cleveland, Ohio

1910 **50 YEARS** 1960



ENGINEERING **YODER** MANUFACTURING

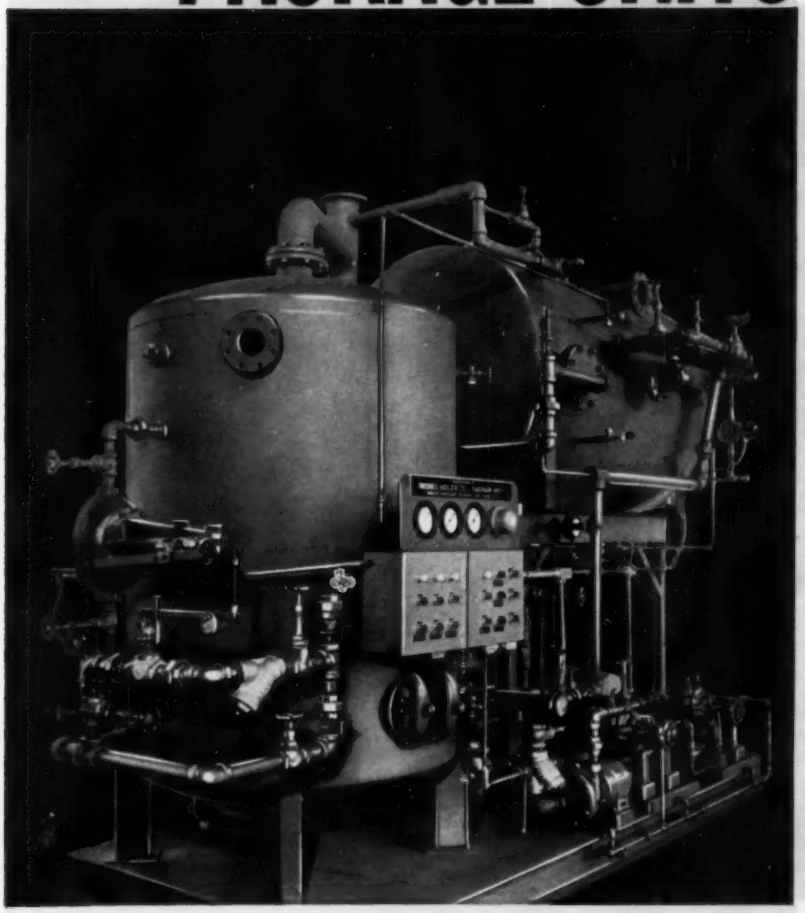
ROTARY SLITTING LINES

PIPE AND TUBE MILLS (ferrous or non-ferrous)
COLD ROLL FORMING MACHINES

Circle No. 143 on Readers' Service Card

WICKES BOILER AUXILIARY PACKAGE UNITS

standard



Save On First Cost • Engineering • Building Space • Construction Time • Operating and Maintenance Cost

Wickes Boiler Co. now offers a packaged system of various compact combinations of DEAERATING FEED WATER HEATERS, BOILER FEED PUMPS, CONDENSATE SURGE TANKS and BLOW-OFF TANKS. Standard units available for steam plants of 10,000 to 100,000 lbs. of steam per hour capacity and steam pressure to 300 PSIG. Information on special units of higher capacities and pressures upon request. Each unit is shop-assembled on a structural steel base, completely piped and wired and equipped with all necessary controls and an instrument panel.

173

Write today for Bulletin 59-1, which gives detailed engineering information on all three models of Wickes Boiler Auxiliary Package Units.

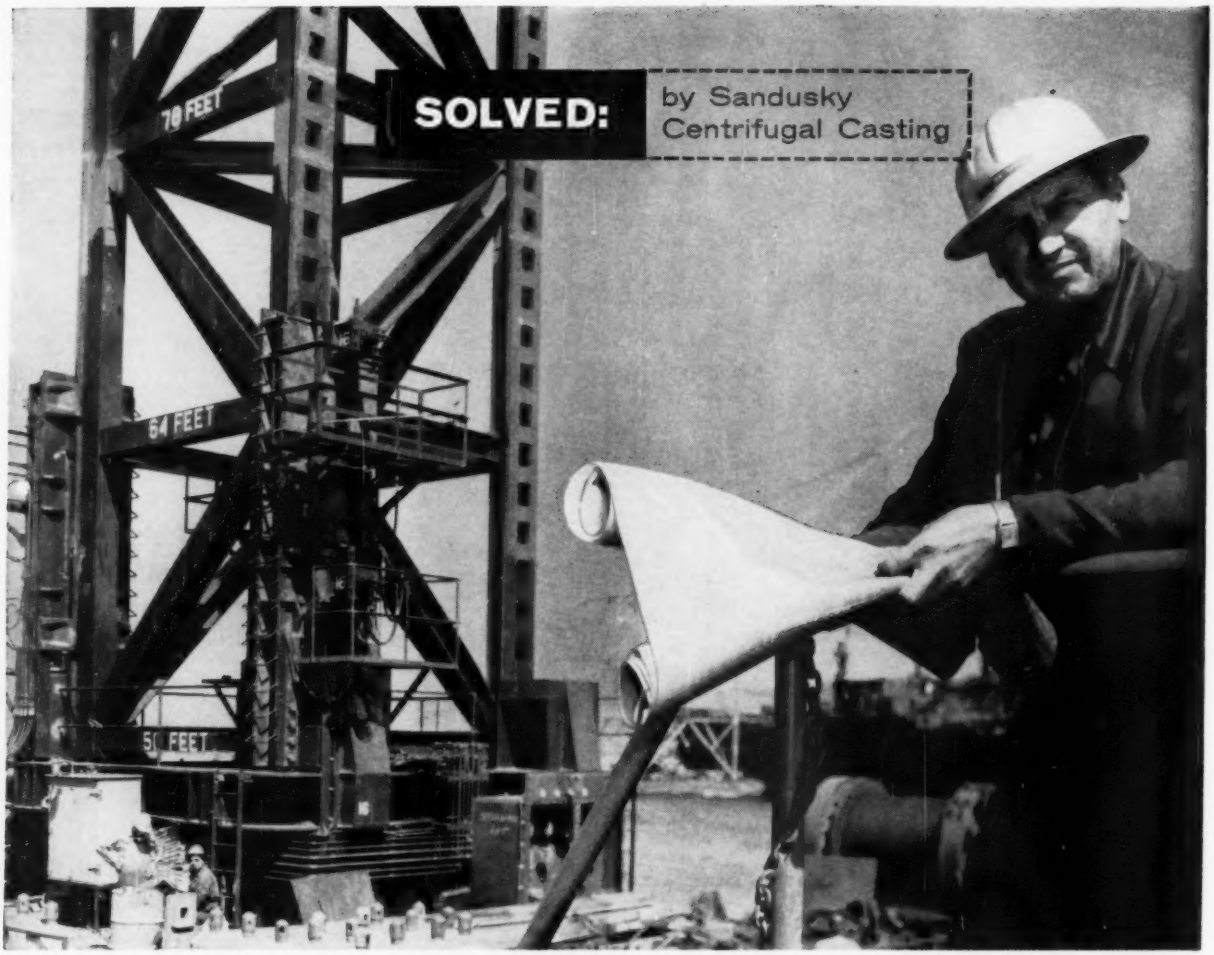
WICKES BOILER CO., SAGINAW 13, MICHIGAN
Division of The Wickes Corporation

WICKES

RECOGNIZED QUALITY SINCE 1854

SALES OFFICES: Atlanta • Boston • Charlotte, N. C. • Chicago • Cleveland • Dallas • Denver • Detroit • Houston • Indianapolis • Los Angeles • Memphis • Milwaukee • New Orleans • New York City • Philadelphia • Portland, Ore. • Rochester, N. Y. • Saginaw • San Francisco • Seattle, Wash. • Springfield, Ill. • Tulsa

Circle No. 136 on Readers' Service Card



One of four 274 ft. high towers aboard the *George F. Ferris* showing method of installing hydraulic jacks built by Yuba Manufacturing Division, Yuba Consolidated Industries, Benicia, Calif. George Bauer, of Delong Corp., New York, is shown supervising construction while platform is being completed at Yuba's Richmond, Calif., plant.

YUBA gets quality-cost-delivery advantages by specifying 16 Sandusky cylinders

Sixteen 500-ton hydraulic jacks built by Yuba, for which Sandusky supplied the main cylindrical bodies, enable the new pipe-laying barge, *George F. Ferris,* to operate in waters 200 ft. deep!

This 5400-ton barge is equipped with four structural steel towers 274 ft. high. Four jacks on each of the towers provide the power to lower these steel "legs" to the ocean floor, raise the barge above the surface of the water, or retract the towers to render the barge navigable. The steel jack cylinders are Sandusky Centrifugal Castings, made to the requirements of ASME Code-approved SA-217, Section VIII, Unfired Pressure Vessels, to withstand operating pressures of 3000 psi. They were produced in 186″ lengths, machined to 24″ O.D. with 2″ thick walls and sectioned into four pieces 43″ long.

Yuba's selection of Sandusky Centrifugal Castings was based largely on three essential factors: QUALITY—meeting the exacting Code requirements . . . COST—saving about half the cost of an alternate method of manufacture . . . and DELIVERY—coming through on a tough time schedule by delivering all 16 cylinders within 21 working days!

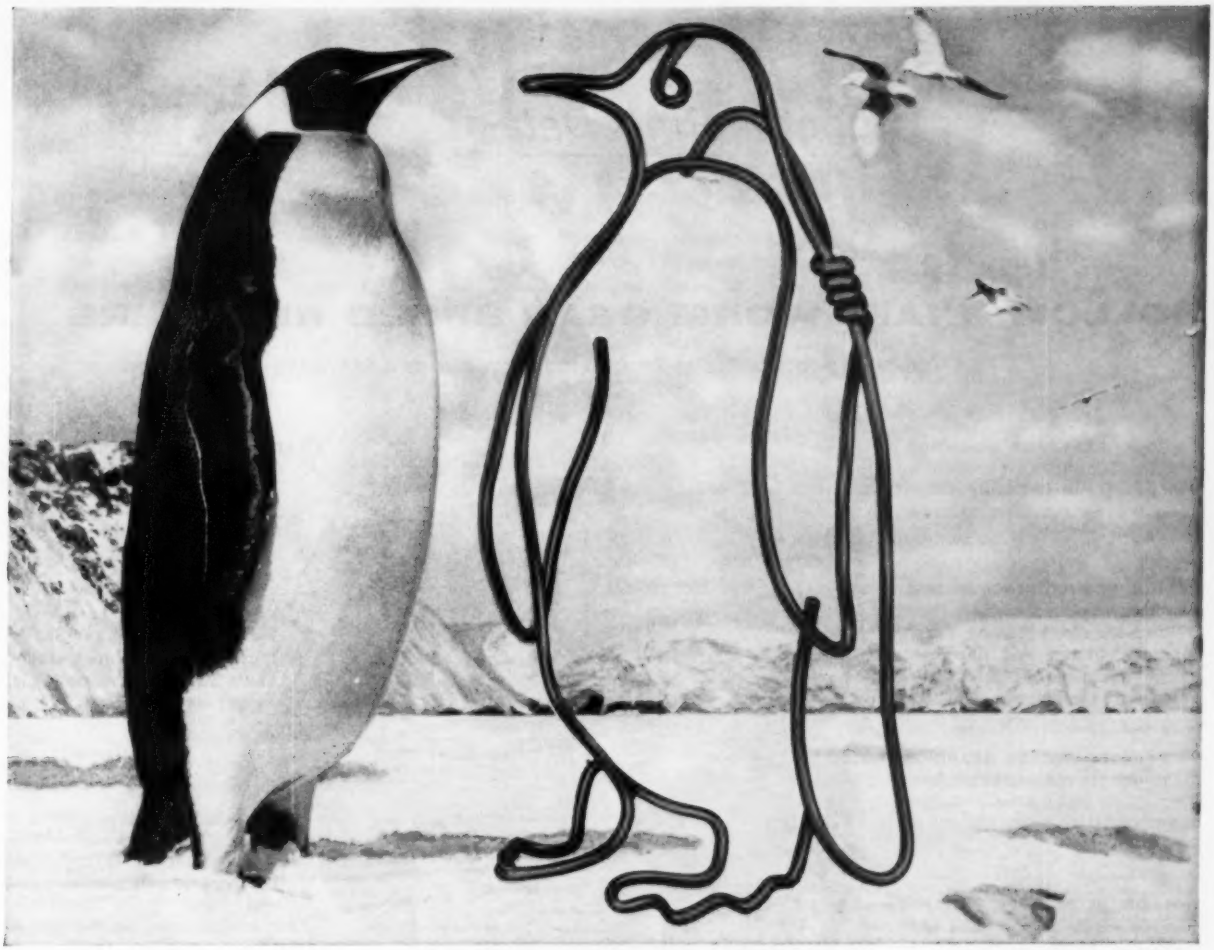
When you need cylinders from 7″ to 54″ in O.D. and up to 33 feet long it will pay you to get in touch with us. Write for our latest booklet, *Your Solution To Cylindrical Problems* containing data on more than 70 ferrous and non-ferrous alloys.

SANDUSKY CENTRIFUGAL CASTINGS
FOUNDRY & MACHINE CO.

8902

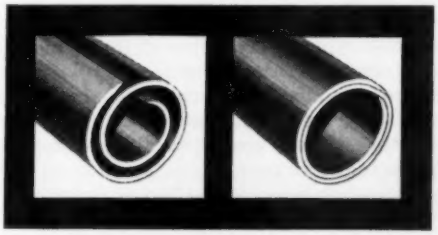
SANDUSKY, OHIO—Stainless, Carbon, Low-Alloy Steels—Full Range Copper-Base, Nickel-Base Alloys

Circle No. 116 on Readers' Service Card



Bundy can mass-fabricate practically anything

You design it. We'll find a way to mass-fabricate it . . . by the millions if needed. Our engineers will work with you at any time. They can often help you find cost-saving solutions to difficult tubing problems by using Bundyweld® steel tubing. For example, Bundyweld can be bent to close tolerances, flanged, upset, expanded, swaged, beaded or special formed. Standard wall diameter and O.D. are held to +.002″ to −.003″. Bundyweld meets ASTM 254; Govt. Spec. MIL-T-3520, Type III. For help, call or write: Bundy Tubing Company, Detroit 14, Michigan.



* * *

Bundyweld, double-walled from a single copper-plated steel strip, is metallurgically bonded through 360° of wall contact. It is lightweight, uniformly smooth and easily fabricated . . . has remarkably high bursting and fatigue strengths. Sizes up to ⅝″ O.D.

BUNDY® TUBING COMPANY

DETROIT 14, MICH. • WINCHESTER, KY. • HOMETOWN, PA.

WORLD'S LARGEST PRODUCER OF SMALL-DIAMETER TUBING. AFFILIATED PLANTS IN AUSTRALIA, BRAZIL, ENGLAND, FRANCE, GERMANY, ITALY, JAPAN.

Circle No. 29 on Readers' Service Card

Engineering Data

WINSMITH SPEED REDUCERS

HOLLOW SHAFT WORM GEAR SPEED REDUCERS

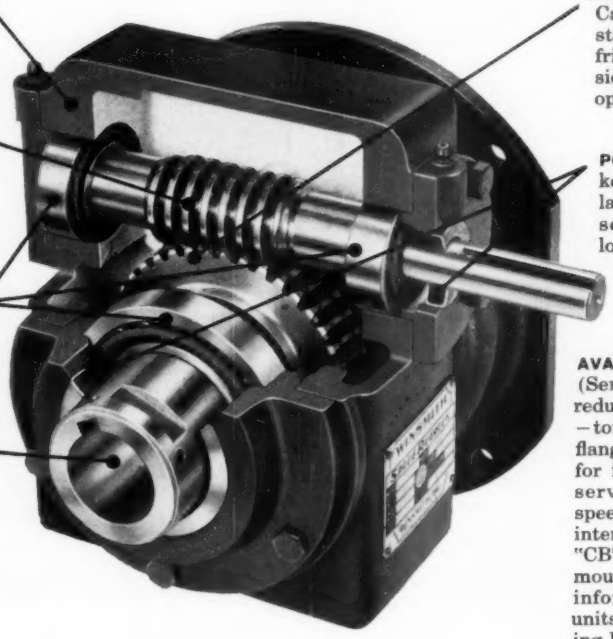
single and double reduction . . . torque arm and flange mounted models

CAST IRON HOUSINGS designed for high heat radiation. One-piece construction, close-grained gray iron for maximum strength and rigidity.

CASE-HARDENED STEEL WORMS cut integral with the shaft. Heat treated for close-grained tough core, carburized and hardened before grinding. Meet AGMA long-wear specifications.

TAPERED ROLLER BEARINGS for minimum maintenance, long bearing life and permanent shaft alignment. High radial and thrust load capacity.

HOLLOW SLOW SPEED SHAFTS in wide range of standard bore sizes and keyways. Mounts on shaft of driven machine *without bushings*—two external slots facilitate removal with standard wheel puller.



SPECIAL BRONZE WORM GEARS Cast to recommended AGMA standards. Low coefficients of friction and thermal expansion for cooler, more efficient operation.

POSITIVE OIL SEALS keep oil in, dirt out. Shafts lapped to micro-finish under seals for uniform contact, longer seal life.

AVAILABLE in single reduction (Series ST and SF) and double reduction (Series STD and SFD) —torque arm ("T" models) and flange mounted ("F" models)—for intermittent or continuous service. Hollow shaft slow speed assembly of "ST" series interchangeable with Winsmith "CB" and "CT" Series with foot mounted housings. For further information on these latter units, write Winsmith Engineering Department.

- *12 Models*
- *.041 to 8.82 H.P.*
- *Ratios 7½:1 to 4466:1*
- *Max. Output Torque 816 to 7678 in. lbs.*

Winsmith Hollow Shaft Speed Reducers cover a broad range of power transmission requirements for both single and double reduction drives. *Their worm gearing provides much higher reduction ratios than are possible in comparable size units using other types of gearing.* Winsmith Hollow Shaft models are designed for all applications where it is advantageous to mount the reducer on the shaft of the driven machine. They are compact, easy to install and require less space than conventional units. Their design and construction provide high shock load resistance; maximum thermal capacity without induced cooling; greater overhung capacity; and a high degree of standardization which eliminates excessive special application engineering.

Write today for complete information or call your nearest Winsmith Representative listed in the Yellow Pages. He is a technically trained expert who is always ready to help you with any speed reducer problem. For both standard and special power transmission applications, you'll find it pays to standardize on Winsmith.

WINSMITH, INC.

203 Eaton Street, Springville, (Erie County), New York

MEMBER OF AGMA

• • • Winsmith Speed Reducers are made by American craftsmen to meet American design and production standards.

Circle No. 138 on Readers' Service Card

MECHANICAL ENGINEERING

VOLUME 83 • NUMBER 4 • APRIL, 1961

Engineers' Salaries

ENGINEERS' salaries—always a subject of great importance—have been analyzed once again by the Engineering Manpower Commission of Engineers Joint Council. The latest study, fourth of a series, entitled "Professional Income of Engineers—1960," gives basic salary information for nearly 200,000 engineering graduates in the United States. And, again, salaries are still trending upward. Between 1958 and 1960, for example, engineers' salary levels rose approximately 5 per cent a year. According to the report, the over-all median salary now stands at $9600. The over-all median (for all graduates) was $6500 in 1953, $7750 in 1956 and $8750 in 1958.

The new $9600 figure is based on the mid-1958 to mid-1960 survey period. In this same span the Consumer Price Index rose 2.3 per cent and the average Gross Weekly Earnings for Production (Manufacturing) increased by 8.9 per cent.

Engineers are a young group, the report notes, with a median age of 32, based on a graduation age of 22. Salaries increase more during the early years of an engineer's career and begin to slow down at about 20 years of experience. This tendency has been less pronounced of late.

Engineering salaries vary markedly in industry, government, and education, with the highest level in industry, followed by education and government, the report notes. Of special interest is the 14.3 per cent increase in the total professional income of engineering teachers between 1958 and 1960. (See MECHANICAL ENGINEERING, February, 1961, page 35).

Data on engineers' salaries in 22 subdivisions of industry (164,657 engineers) including separate curves for all-industry PhD, ScD, and MS graduates are assembled in the report. Also covered are engineering salaries in all levels of government (20,491 engineers), college teachers (over 5000), technical institute teachers, and engineering societies. The report covers about a quarter of U. S. engineers.

As in previous studies, graphic and tabular presentations show upper and lower decile and quartile salaries and the median salary by years since the baccalaureate degree. Also shown are the number of engineering graduates earning $25,000 and over and the number earning less than $5000.

Altogether, 597 companies and 133 government agencies replied to mailed questionnaires. (See "The Roundup" for additional details.)

Salarywise, this survey is said to constitute one of the largest representative samples of engineers ever studied in the United States. In general, the industry sample represents about one fourth of the total engineering employment; the government sample about one sixth.

Certain industrial groups—chemical, utility, petroleum, and electrical and electronic in particular—are strong supporters of this survey activity. However, there was a sharp decline in participation of agencies in the Federal Government. In 1958, the response from Federal Government represented 42 agencies covering 18,720 engineers as opposed to 25 agencies covering only 8652 engineers this year. As in previous surveys, the automotive industry did not participate.

The report makes interesting reading . . . and the curves provide a host of useful data on engineers' salaries. Copies are available from the Engineering Manpower Commission, EJC, 29 West 39th Street, New York 18, N. Y., at $3 a copy.—*J. J. Jaklitsch, Jr.*

Editor, J. J. JAKLITSCH, JR.

For rote learning, a machine may do a superior the job of teaching. Can it teach an engineering student to think, to be creative? Here are the pros and cons of that psychologists' invention, The Teaching Machine.

THE IDEA of using machines for purposes of teaching originated with psychologists. Their intention was not to seek labor-saving devices. They merely sought to investigate a fundamental theory concerning the learning process. Basically, this theory asserts that learning is a simple stimulus-response process whereby the desired response to a given stimulus is stamped into a person's consciousness through adequate repetition. Thus repetition will eventually cause a pupil to associate the response "28" with the stimulus "4 times 7."

The "associationists" maintain that the most effective learning will occur when two principles are followed. First, the pupil must make an active response to the stimulus (or teacher's question). And second, the pupil must be informed immediately as to the correctness of his response. Essentially, this is a tutorial technique.

The Mechanical Teacher

The present-day effort to mechanize teaching has revivified the teaching machine. There is activity in educational circles, and at least a dozen companies are currently manufacturing such devices. The variety of designs ranges from rudimentary pocket-size models to electronic behemoths replete with panel lights, push-buttons, and projection screens. But all are based on the same pedagogic rationale.

An enclosed box, about the size of a phonograph, has a small window cut into its top. An indexing turntable inside the box carries a paper disk on which is imprinted a sequence of questions and correct answers (the "program"). The box rests on a table and the pupil sits before it. Its operation is entirely under his control.

Question No. 1 (but not its answer) appears in the window and the pupil writes his response on a paper tape. He next uncovers the correct answer, compares it to his own, and records success or failure. He then indexes question No. 2 into position at the window, repeats the procedure, and continues through the entire set of questions. At this point, the machine recycles. But it presents only those questions which were failed during the preceding run. After all questions have been answered correctly the lesson is concluded.

Other machines differ in such features as mode of presentation (flash cards, tape recorder, etc.), mode of response, anticheat devices, and recycling systems. But all embody the two basic principles of active response and immediate knowledge of results.

Programming the Machine

The quality of the program is a vital factor in the machine's effectiveness. The finest machine will fail if the program is poor. It is fairly well established that the material should be presented in a logical, sequential manner. Information should be fed in small increments with never more than one new bit per question. The following excerpt from a program in electrical circuits which was prepared for sophomores in a liberal-arts college illustrates the general technique:

A Program Excerpt

1 In driving a nail into a piece of wood, the depth of penetration depends on the force of the hammer blow and the resistance of the ——. **(wood)**

2 The penetration is directly proportional to the —— of the blow, and inversely proportional to the —— of the wood. **(force; resistance)**

3 In a flashlight, the flow of current through the lamp is a function of —— of the battery and resistance of the lamp filament. **(electromotive, force, emf)**

4 Current can be increased either by increasing the emf or —— the ——. **(decreasing; resistance)**

5 In an electrical circuit there is a mathematical relationship between emf, resistance, and ——. This relationship is known as Ohm's Law. **(current)**

6 Ohm's Law states that current is directly proportional to ——, and inversely proportional to ——. **(emf; resistance)**

7 In symbols, **I = E/R** is a mathematical statement of ——. **(Ohm's Law)**

By **S. W. Groesberg,** Mechanical Engineering Department, Stevens Institute of Technology, Hoboken, N. J.

teaching machine

Can machines teach? The experimental evidence furnishes the answer, an unequivocal yes. But a further and equally cogent question still remains: Should machines teach? In critically comparing the machine and the classroom methods, we analyze both the machine and the "hand" process with respect to three weighted factors—speed, cost, and quality.

Speed? Cost? Quality?

Consideration of the first factor, speed, indicates a clear advantage for the machine. In the classroom, the entire group advances at some specific pace. But the teacher sets this pace so as to accommodate the weakest segment of the group. As a result, the more capable pupils find themselves tethered to the stragglers. A teaching machine, on the other hand, enables each pupil to proceed in accordance with his individual ability. Plainly, the machines will produce at the more favorable rate.

The second factor is cost. A given group of pupils is serviced either by one teacher or by a quantity of machines equal to the number of pupils. Hence the total annual cost of the machines will probably be greater than the salary of the equivalent teacher. But this is counterbalanced by the more tractable work habits of machines. They willingly work double, triple, or centuple sessions without additional remuneration. A long day never makes them irritable.

An additional element affecting cost is the investment in development and research. Sizable expenditures of money and talent are still necessary in order to perfect the machine and its appurtenances. But if teaching machines are not adopted, the manpower deficit continues and funds must be set aside for the training of additional teachers. The cost picture, therefore, shows no advantage for either the machine or the teacher.

Turning to quality, it is first necessary to define quality as it applies to the learning process. A useful approximation can be effected by classifying all learning into two categories: rote and transfer. Rote learning refers to the acquirement of knowledge or skill through brute memorization. No concept formation is involved. Transfer learning, on the other hand, must be accompanied by insight and reasoning.

On the basis of such a definition, a simple measure of superior quality in the case of rote learning would be the amount of material memorized and retained. A substantial number of studies on the teaching of rote material by machine has been made. These studies covered such diverse subjects as arithmetic, spelling, foreign languages, psychology, and typing. The results unanimously confirm that, in the area of rote learning, machines teach at least as well as, and some times better than, the classroom method.

In the case of transfer learning, one satisfactory (but by no means ideal) index of quality is performance in problem-solving. One such study has been made in which the subject matter dealt with electrical-circuit theory. This is a problem-solving type of learning and the results showed that the machine group did not perform as well as the classroom group. But any reliable generalization must await additional data, and it may be possible to hypothesize about the probable trend.

The essence of transfer learning is the ability to perceive existing relationships and to generate new ones. But the teaching machine, by its very philosophy, actively militates against this sort of aptitude. It is deliberately designed to elicit the favored response and to discourage all others.

Summing Up

The comparison of machine and classroom teaching can thus be summarized as follows:

Speed: A big plus for the machine.

Cost: About even.

Quality: Rote learning shows a modest but significant advantage for the machine. In transfer learning, the classroom holds a tenuous edge. Later returns, however, may change this to a solid plus.

Where the aim of the institution is to impart a specific body of knowledge or skill, the machine can do the job faster, cheaper, and with fully acceptable results. It is, in fact, probable that in the near future training programs of a specialized nature will be handled entirely by machines.

Where the aim of the institution is to produce educated rather than trained persons—as in engineering—the objectives are broadened. Education is more than knowledge. It is knowledge abetted by mental and moral vigor. Both classroom and teacher make irreplaceable contributions.

The classroom serves as a crucible for disciplining group activity. It promotes cross-pollinating discussion and refines communicative skills. The teacher contributes by providing a rallying point. He clarifies, unifies, and adroitly channels (but never squashes) the unorthodoxies of imaginative minds. He motivates, provokes, and, not infrequently, inspires.

Automation, Yes; Automatons, No

This is not to say that there is no place for the teaching machine in the educating institution. Like blackboards, film strips, etc., they can serve as valuable instructional aids. A judicious balance of classroom and machine sessions is advisable because a steady diet of short-answer pablum will merely advance conformity and penalize the venturesome mind.

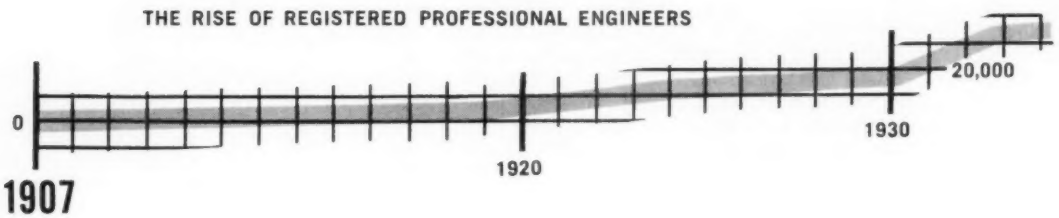
A Word to the New Graduate

In many states, the newly graduated engineering student has an opportunity to take part of his state examinations immediately, while his college training is fresh. He wins "Engineer-in-Training" certification. There remains "Qualifying Experience," and then he's a licensed engineer.

A good way of securing information is to get a copy of the law from your State Registration Board. The Secretary of the National Council of State Boards of Engineering Examiners (NCSBEE), P.O. Drawer 752, Clemson, S.C., can supply the address of any of the member state boards.

FOR PROFESSIONAL ENGINEERS—

By **J. C. Marshall**[1], Mem. ASME, The Procter & Gamble Manufacturing Company, Chicago, Ill.



THE increased interest of mechanical engineers in securing their professional registration is apparent, as reflected in the number of applicants in many of the states. Close to 250,000 engineers are now registered in the U.S. In many industrial and business organizations, the registered engineer is recognized and encouraged, although he may be exempt from any direct registration requirement by specific exemption or subordinate position.

The first state law to license engineers appeared in 1907, in Wyoming. Among engineering societies, the American Society of Civil Engineers acted first to propose a model law for the guidance of state legislatures in developing suitable laws. Since then, the engineering societies, among them ASME, have worked together to maintain an up-to-date model law. Revisions took place in 1925, 1927, 1929, 1937, 1943, 1946, and in 1960.

The 1960 Revision

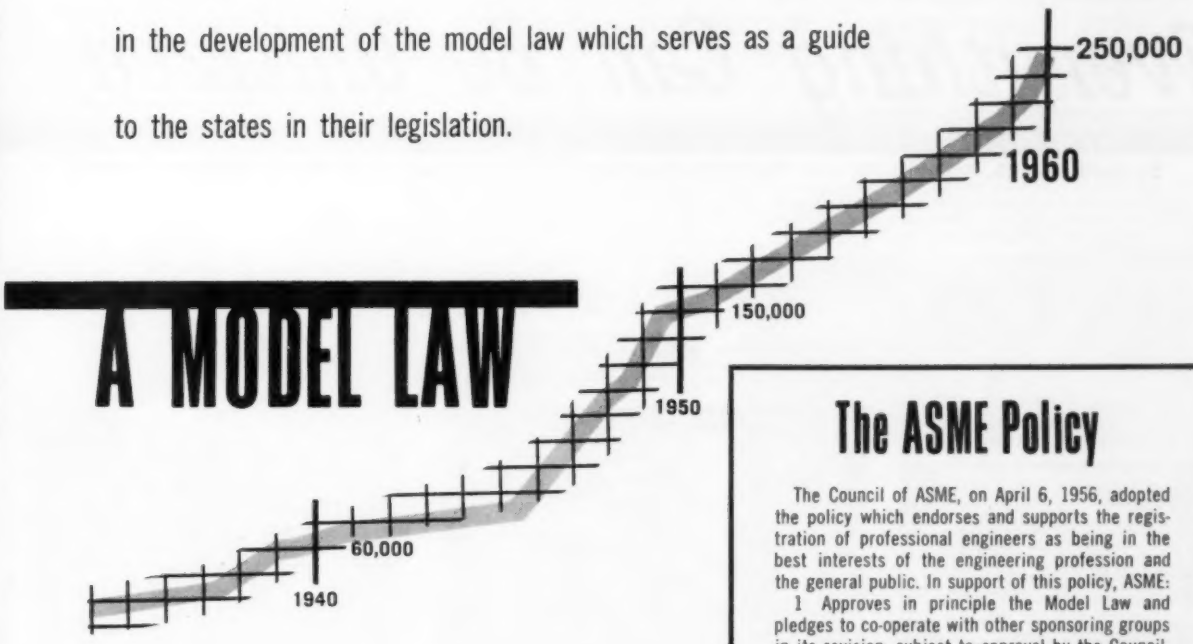
The new model law received its final endorsement by the National Council of State Boards of Engineering Examiners meeting in Portland, Ore., on Aug. 19, 1960. The 1960 model law follows the general provisions from many of the current statutes prevalent in the states. It tends to be somewhat more stringent in some details. For example, nongraduates of accredited engineering curriculums must have 12 years of experience for admission to the 16-hour examination. General rules for registration by endorsement for applicants from other states and holders of National Bureau Certificates are covered.

The form of organization as set out in the model law, for the practice of engineering, may be any one of the usual types, providing each individual professional engineer assumes his full responsibility for all work under his direction, and providing he is registered. There are several views held on what should be the best arrangement for licensing of organizations offering engineering services. The majority opinion seems to be that, as long as individual responsibility is established, any conventional form of organization is in order.

Individual professional development in mechanical-

[1] Chairman of the Engineers Registration Committee, Board on Education, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

As an engineer, you are — or should be — a true professional, not merely an employee, but legally registered to practice engineering in your state. ASME has taken its part in the development of the model law which serves as a guide to the states in their legislation.



A MODEL LAW

engineering careers leans heavily on two choices open to the engineer. He may, if qualified, gather unto himself a substantial amount of professional identification by becoming associated with ASME. He may also qualify for registration in his state.

The policy of ASME has, in effect, followed that of ASCE, which now requires that a member be registered in the state in which he operates in order to be eligible for the grade of Fellow. The ASME policy has for many years endorsed and supported registration. Although many mechanical engineers are not legally negligent in their failure to obtain registration, registration has the distinct advantage of formalizing the engineer's lawful practice in the areas of his competence.

Investigate Your State's Requirements

Mechanical engineers who are not registered might well investigate the situation in their state of residence as the model law becomes more exacting and the number of registered engineers grows. A letter to the Secretary of the State Board of Engineering Examiners will bring information on current requirements.

The ASME Policy

The Council of ASME, on April 6, 1956, adopted the policy which endorses and supports the registration of professional engineers as being in the best interests of the engineering profession and the general public. In support of this policy, ASME:

1 Approves in principle the Model Law and pledges to co-operate with other sponsoring groups in its revision, subject to approval by the Council.

2 Offers its facilities to assist in the appropriate revision or modification of registration acts in States where responsible organizations request such assistance.

3 Supports financially the activities of the National Council of State Boards of Engineering Examiners and gives advice and assistance to the Council when requested.

4 Recommends that there be no discrimination by implication, omission, or direction as to the form of business organization (individuals, partnerships, corporations, or others) under which the practice of engineering is conducted provided that the person or persons in responsible charge of such practice be legally registered professional engineers.

5 Recommends that each Section appoint a standing committee known as the Registration Committee to co-operate with the State Registration Board and the Section Program Committee in the dissemination of information concerning registration.

6 Recommends that each Section devote some time in a Section Meeting each year to the subject of engineering registration where, if possible, a member of the State Registration Board would address them.

7 Recommends that, in states in which written examinations are required of applicants for registration, Sections co-operate with other groups in sponsoring refresher courses.

8 Recommends that each Student Section devote a session to engineering registration where, if possible, a member of the State Registration Board or a prominent registered professional engineer would address them, placing special emphasis on the purpose of registration, the standards required for registration, the Engineer-in-Training program, and the procedure for applying for registration.

ALMOST
Everything Can Be Unitized

By J. H. Bates, Industrial Engineer, Material Handling Plant Engineering Department, Allis-Chalmers Manufacturing

Automobile heater fans are shown unitized in large, reusable corrugated paper containers, eliminating the expense of individual boxes

A 3000-lb-capacity corrugated box, for unitizing small packages and loose material. The boxes are storable four high, loaded. Cost, $3.59 each.

Showing tractor engine blocks, unitized sixteen to the pallet with steel straps, employing corner protectors where the two steel straps go around sharp corners

An Allis-Chalmers survey: More savings per dollar of expenditures can be achieved by

The pallet isn't always the answer. Here it won't work. It is too expensive to unitize this small material on pallets. Loose gear blanks are shown conveniently unitized in stacking-type skid boxes.

These are heavy. Electric motor housings are pictured here, easily unitized, 16 to a layer, 48 on each pallet. This was accomplished with the aid of spacers, using a top cover and six steel straps.

A UNITIZING program in your plant can result in 80 to 95 per cent savings of indirect labor cost in handling incoming shipments of raw materials, in-process materials, and finished materials. Almost any shape, size, or weight of material can be unitized.

Based on Mr. Bates' paper, "How, to Employ Unitization in Your Plant," presented at the Production Engineering Conference, May 17–19, 1960, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

To begin a program of unitizing, standard sizes of unitizing equipment, compatible with all your plants, should be set up. Select optimum sizes for your use, since at this time there are no standard sizes of pallets, pallet boxes, and skids.

Unitizing starts with your suppliers. Have all multiple-item incoming shipments unitized on your standard-sized equipment. Your suppliers' costs will probably be amply covered by their savings from handling unitized material instead of loose material. Your suppliers can buy your sizes locally at the same cost as you do.

Standardize your storage racks to fit your standard sizes of pallets or containers to obtain maximum use of "air rights for storage."

The pictures show a number of different ways of unitizing various types of materials.

Company, Milwaukee, Wis.

Lost time formerly required to open corrugated containers and dispose of them is eliminated by a new method. Now 12-piece containers are out, and 144 pieces are unitized on a wood pallet with contour-fitting returnable spacers.

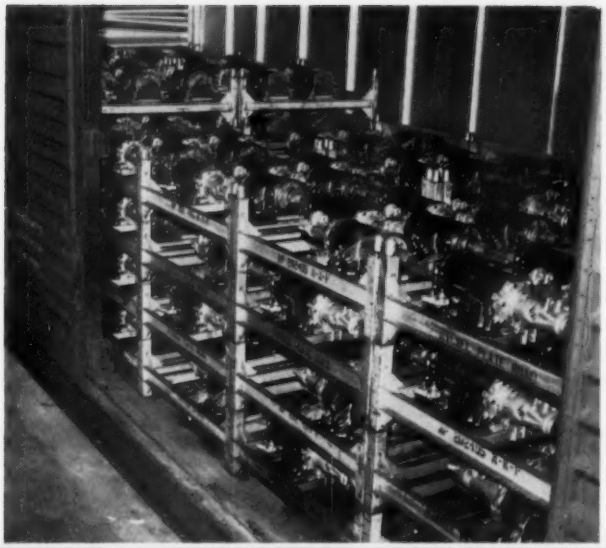
Bags of cement, resin, and sea coal palletize easily for "in-plant" movement. Palletizing glue and heavy scotch or steel tape is called for on long hauls. Have suppliers ship bagged material to you on your standard wood pallets, providing make-up for your pallet pool.

unitizing incoming material than at any other place in the plant.

Three truck frames, unitized with steel straps and spacers, stacked ten high without racks. Now, with a heavier fork lift and heavier steel strap, they are stacked fifteen high in bundles of five.

Castings on hand: Small castings economically unitized in wire-bound, wood-slat boxes. Further back, larger castings are unitized with lightweight spacers and two steel straps on pallets.

ALMOST
Everything Can Be Unitized



Completely assembled automobile transmissions are shown here unitized on special steel racks for shipment between plants in assigned cars, and for storage adjacent to the assembly line. Railroads are eager to get this kind of business, and will build special cars for assignment. You guarantee a designated number of trips per year. You buy the racks, give them to the railroad, and then lease them back for $1.00 per year, with the provision that you are responsible for keeping them in repair—an inspection each trip. Since the rack weight is considered part of the tare weight of the car, no freight is charged for racks. As a car of this type, with unitized loads, can be unloaded in two man-hours, and reloaded in two hours, you will never have a demurrage charge to pay. Look into this method of shipping material. It could save you thousands of dollars yearly on reduced freight charges, as well as up to 90 per cent on the man-hours required to handle loose material, plus damage-free shipping.

Just because it isn't hard, is no reason it can't be unitized. Here, the cargo is burlap bags, unitized by tying with wire.

Or, it can be hard and ungainly, and still be unitized. Here was an outstanding economy. Unitizing bundles of Orangeburg soil pipe with two steel straps reduced labor 80 per cent between cut-off line and loading.

A unitization program in your plant can result in 80 to 95 per cent indirect labor cost savings in handling incoming shipments of raw materials, in-process materials, and finished materials. In this picture, 24 green cement blocks on the way to the drying ovens are shown as they are economically unitized in specially built racks, thereby eliminating individual handling or stacking in the ovens.

This is the latest thing in material handling of unitized material. A riderless tractor, following a wire embedded in the floor or a stripe of paint along a designated path, pulls a string of four-wheeled carts. A selector switch permits the train to stop at any predetermined destination. Then a red light flashes and a bell rings until the unitized load has been removed and another button pushed on the selector box. An electronic bumper brings the train to a stop whenever somebody steps in front of it. As soon as the obstruction has been removed, the train will proceed on its way.

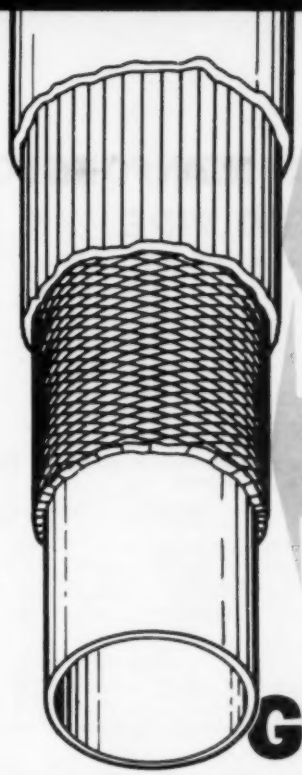


Fig. 1 Typical glass-reinforced plastic pipe of the externally wound type. Minor differences are found in the pipe of different manufacturers.

GLASS-REINFORCED PLASTIC PIPE

By Robert M. Levy, Engineer
Esso Research and Engineering Company, Linden, N. J.

Many characteristics make this pipe structure attractive. The resins, brittle and low in tensile strength, call for reinforcement. Glass fibers give the pipe its strength.

ONE OF the more recent and most promising materials for noncorrodible piping is plastics—and more particularly, glass-reinforced thermosetting plastics. In addition to corrosion resistance, glass-reinforced plastic pipe has high strength, light weight, improved flow characteristics, resistance to paraffin deposition, low thermal and electrical conductivity, noncontamination of product, and ease and economy of installation. Unlike most other piping materials, glass-reinforced plastic presents a most complicated physical-behavior pattern under the combined actions of stress, environment, and time. This pattern is affected greatly not only by the individual behavior of the reinforcement material and the plastic, but the interaction of the combination. Because the technology of the glass-reinforced plastic is comparatively new, much remains to be learned of the mechanisms involved in this combined behavior.

Types of Plastics

Plastics generally fall into one of two distinct divisions —thermoplastic and thermosetting—each with its own general properties. Various types of plastics commonly found in piping and tube forms are listed, Table 1.

Thermoplastics. Thermoplastics can be softened upon heating, remolded to any given form, and will still retain essentially all of their original properties when restored to original temperature. The major types presently being used in the manufacture of pipe are polyethylene, polyvinyl chloride, butyrate, and Kralastic (a styrene-rubber "alloy"). Polypropylene, one of the newer thermoplastics, appears quite promising [1].[1]

Thermoplastic pipe has found wide application in the petroleum industry, mainly because of its good corrosion resistance and light weight. However, its use is limited to low-pressure service. Use at temperatures over 150 F or below 40 F is generally not recommended. It is susceptible to cold flow and consequently must be supported almost continuously to prevent excessive deflections. In addition, it has a high coefficient of thermal expansion—on the order of ten times that of steel.

Thermosets. The reinforced thermosetting pipe is designed to continue on in strength and temperature properties where the thermoplastics end. Thermosetting plastics, as the name implies, set or harden under heat to the final form which cannot be changed upon reheating. Currently there are three types being used in pipe manufacture—polyester, epoxy, and phenolic. A new thermosetting resin trade-marked Buton by the Enjay Chemical Company appears promising [2].

Since the resins used are generally brittle in nature and low in tensile strength, reinforcing is required. Reinforcing is usually in the form of glass fiber, although cotton, sisal, paper, asbestos, glass cloth and mat, and organic fibers have been used.

Actually, the resins contribute very little to the strength of the structure. Their main functions are stress transfer, protection for the reinforcement from external physical and chemical attack, and, in the case of glass, protection from the abrasion of the glass on itself. In addition, the resin serves to stabilize the reinforcement filaments when the structure is put in compression.

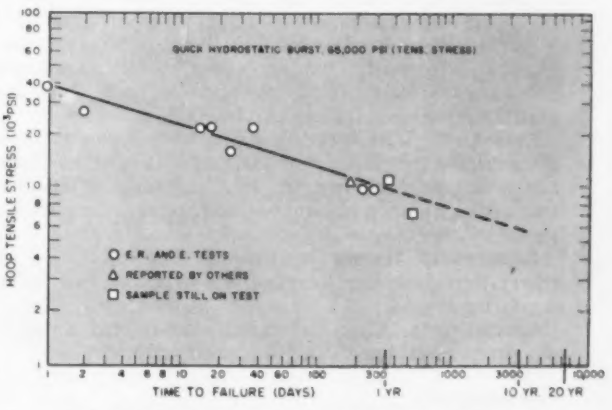
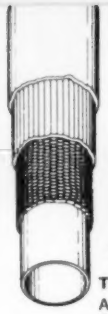


Fig. 2 Typical S-N curve for 150-F water environment

[1] Numbers in brackets designate References at end of paper.

Contributed by the Petroleum Division and presented at the Petroleum Mechanical Engineering Conference, New Orleans, La., September 18–21, 1960, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Condensed from Paper No. 60—Pet-38.



GLASS-REINFORCED PLASTIC PIPE

Table 1 Types of Plastic Pipe and Tubing

Thermoplastic	Thermosetting
Acrylic	Epoxy
Celluloses	Furan
Fluorocarbons	Phenolic
Polyamide	Polybutadiene
Polyethylene	Polyester
Polypropylene	Melamine
Polystyrene	Silicone
Polyvinyls	

Table 2 Demonstrated Uses of Glass-Reinforced Plastic Pipe [13] (Partial Listing)

Fluid transported	Temp, deg F	Pressure, psi
Hydrochloric acid, concentrated	60–260	0–500
Hydrofluoric acid, 10–30%	100–300	0–85
Phosphoric acid, 40–79%	200–300	50–200
Sulfuric acid, 60%	260	30–300
Sulfuric acid, 10–50%	100–290	0–250
Nitric acid, 5%	180	100
Chlorine, dry	90–120	35–75
Brine	40–275	0–1350
Benzene	80–120	150–500
Xylene	60–200	15–700

Note: The above data are not necessarily applicable to all types of glass-reinforced plastic pipe.

Since properties of resins differ according to suppliers, formulation, cure cycles, and many other variables, no attempt will be made to discuss resin properties. Much has been published in recent years [3, 4, 5].

Most of the thermoset pipe being produced or in development is of glass-reinforced epoxy resin, and this will be specifically referred to in the remainder of this discussion, although much is applicable to polyester, Buton, and other thermosetting pipe.

Properties of Glass Reinforcement [6]

The glass fibers commonly used in reinforcements are made of a borosilicate type of glass commonly referred to as E glass. The glass fiber when drawn is of the order of 0.0002 in. in diam; 204 fibers are usually drawn together to make a strand or end. Twenty to 60 ends are then drawn together to form a roving for the pipe manufacture. Some of the glass properties in this form are:

Tensile Strength. Whereas the calculated theoretical values for the strength of fibrous glass vary from 1 to 14×10^6 psi (depending on the theory used), laboratory tests have yielded values of from 0.5 to 0.8×10^6 psi (depending upon the care exercised). However, 200,000 psi is probably as high as one can expect from commercial glass as received. Further handling, before the final product is formed, could reduce this to 100,000 psi. Laboratory tests on the glass-reinforced pipe show the glass to invariably sustain the 100,000-psi figure.

Elastic Limit. Within the operating temperature range of glass-reinforced plastic, the elastic limit of glass is the same as its ultimate strength; in other words, it possesses true elasticity with no yield. At rupture, elongation is about $3^1/_2$ per cent.

Coefficient of Thermal Conductivity. The coefficient of thermal conductivity for glass is about 0.06 Btu per sq ft per deg F per ft.

Specific Gravity. Glass is generally considered a lighter weight material with a specific gravity of 2.55.

Pipe Structure

In general, glass-reinforced pipe is composed of two or three materials—glass fibers, plastic matrix, and an inner liner. The glass fibers which comprise about 60 to 80 per cent of the pipe material are used as a structural cage, and carry the major part of the load. Damage to these fibers can cause serious loss of strength. Most pipes have an inner liner of either polyvinylchloride or epoxy.

Before the glass fibers can be used as reinforcement, a pretreatment is required. During the manufacture of the fiber a sizing agent and lubricating agent are added to the glass. This serves to keep the fibers together while minimizing the effects of the glass abrading upon itself. These agents are usually either removed before application or are designed to dissolve in the particular resin.

In addition, a coupling agent is also applied to the glass. This is designed to provide a chemical link between the glass and the resin. While this effect is generally accepted it has not yet been proved conclusively. Some recent work, however, offers strong substantiation [7]. There is some opinion, however, that the bond between the glass and resin is largely a mechanical one, being mainly derived from the friction between the two materials. The friction forces are derived from the compressive stresses set up by the differential shrinkage incurred when the two materials cool from the reaction temperatures.

Pipe Manufacture

There are several manufacturers of glass-reinforced plastic pipe. Each uses a different method of fabrication. These fall roughly into two types—external mandrel wrapping and internal mandrel casting [8]. The external-mandrel-wrap pipe is made by winding resin-impregnated glass fibers around a polished mandrel and subsequently curing with heat. In the internal-mandrel process, the glass and resin are preplaced inside a mandrel and cast by use of centrifugal force and heat.

In both cases, the glass fibers can be oriented in any direction to provide maximum strength in the direction of maximum load. A cutaway of a typical externally wound pipe is shown in Fig. 1, although minor differences are present with any particular manufacturer.

Pipe Properties

Operating Conditions. There are no standard schedules in glass-reinforced plastic pipe as there are for steel pipe, although the trend is toward standardization on iron-pipe OD sizes. The plastics are rated by each manufacturer for his particular product. Small size (2-in-diam) pipe is currently available that will operate to 1500 psi. Temperature ranges are from -50 to $+300$ F.

Corrosion Resistance. The outstanding advantage of plastic pipe is its corrosion resistance; it is immune to the usual corrosion mechanism of electrochemical attack. Chemical attack may occur on the plastics, resulting in contamination, although this also results in the deterioration of the pipe and represents a misapplication. Chemical attack on the plastic material in the pipe is usually of the "go or no-go" type. Either the attack is suffered rapidly, or the plastic is completely resistant [9].

On the other hand, attack on the glass reinforcing or at the glass-resin interface is a more gradual type of degradation. Time is usually required for the reagent to reach the glass and then attack a sufficient amount of glass to cause failure. One of the most common materials which attacks glass in this manner is water.

A few of the demonstrated uses of glass-reinforced plastic pipe, showing some of the corrosive fluids that may be transported, are listed in Table 2. This list is merely an indication of the material's chemical resistance and does not necessarily limit the pipe to these conditions. Many other corrosive services are possible. The manufacturer should be consulted for a particular service.

Weight. The weight of glass-reinforced plastic pipe is about $^1/_4$ to $^1/_5$ that of steel and about $^2/_3$ that of aluminum. This light weight facilitates handling, decreases shipping costs, and results in a faster installation. These advantages become markedly apparent in larger sizes. For example, 6 or 8-in. plastic pipe can be readily handled by one or two men, whereas power equipment is needed to handle steel pipe.

Flow Characteristics. The interior surface of the glass-reinforced plastic pipe is generally smoother than steel, perhaps approaching that of glass. The Williams and Hazen flow coefficient is in the range of 145 to 150, whereas for steel it is about 130. This will yield greater flow through plastic than through steel pipe under the same conditions. Furthermore, the coefficient tends to decrease with time for steel (to about 90) as corrosion occurs; with plastic it remains relatively constant.

Antifouling Characteristics. In handling highly paraffinic crudes, wax deposition along metallic pipe walls can be a serious problem. In some oil fields, even oversized pipe must be cleaned as often as every other day.

By using plastic pipe, the rate of paraffin deposition is radically reduced. In most cases, there is no deposit. This is probably due to the smoothness of the pipe, its low thermal conductivity, and its noncompatibility with the wax. Recent tests at The University of Texas have not only demonstrated reinforced plastic pipe's superiority in this respect over metallic pipe, but also indicate some advantage over thermoplastic pipe [10].

Heat Transfer. The low-heat-transfer characteristics of plastics are well known. The military is using plastics where skin temperatures are in the thousands of degrees while the interior is relatively cool [11]. Where heated liquids are being transported, the advantage of having a low thermal coefficient is readily apparent.

Pipe Strength. Static bursts on 2-in-diam pipe have shown ultimates of up to 8000-psi internal pressure or 70,000 to 80,000-psi tensile strength. However, this is not the complete story. If the 8000-psi pipe were held at some lower pressure, say 4000 psi, failure might occur in a very short period of time. The long-term strength of the pipe is quite dependent upon the time, pressure, temperature, and environment.

The only reliable method presently available to predict safe operating pressures is to test under long-term conditions. It is doubtful that any universal correlation for determining long-term properties from short-term tests will be available in the near future. Much must still be learned of the mechanisms involved.

Test Methods

Since there are no standard tests available for glass-reinforced plastic pipe, appropriate test methods have had to be established. There are many types of tests currently in use. These include the static or quick hydrostatic burst, pulsating internal pressure (dynamic fatigue), edgewise porosity of the pipe wall, and others. Perhaps the most meaningful test is a sustained pressure (static fatigue or stress-rupture) test, since it is the laboratory test that nearly approximates field conditions.

In this test as run at Esso Research and Engineering Company, the pipes are submerged in a 150-F water bath, hydrostatic pressure is applied and maintained. The time to failure is recorded. The temperature selection is arbitrary and serves to limit the scope of the test. For a more complete performance picture, the entire temperature range should be covered.

Fresh water is used since this readily attacks the glass-fiber bond. As a matter of fact, distilled water is probably one of the most "corrosive" fluids the pipe could carry. The water will not only attack the bond, but will actually dissolve glass. Since the surface area of the fiber is so great compared to its volume, the fiber is readily destroyed. On the other hand, salt water has less effect on the pipe [12].

When the results are plotted as a stress-rupture curve on the appropriate co-ordinates (log-log appears most suitable), the values produce a straight line.

A typical stress-rupture curve is shown in Fig. 2. Each point represents one or more test values. As can be seen, although the pipe will originally fail at a hoop tensile stress of 65,000 psi under the conditions tested, a 5:1 factor of safety is inadequate. A factor of safety in the range of 10:1 to 20:1 is called for (depending on field conditions and length of service required).

One, perhaps obvious, note of caution should be mentioned. Since data of this type are obtained under a fixed set of laboratory conditions, judicious care should be exercised when extrapolating to design stresses. In addition to reflecting no factor of safety, external stresses produced by bending, overburden, water hammer, local impacts, thermal changes, and others are not accounted for in the results of this test. Since these stresses are additive in most cases, the operating stresses must be adjusted to account for them.

Applications

In the petroleum industry, the principal use of glass-reinforced plastic pipe is believed to be in crude-gathering lines, salt-water disposal lines, and water-flooding operations. As down-hole tubing, it has been used in salt-water disposal wells, pumping wells, and combination injection and disposal wells.

Limited applications can be found in refinery offsites and aboard tankers.

References

1 C. Crespi, *Materials in Design Engineering*, vol. 47, January, 1958, p. 110.

2 R. M. Levy and B. M. Vanderbilt, Society of the Plastics Industry, 15th Annual Technical and Management Conference, Section 13-D, 1960.

3 J. Bjorksten, et al., "Polyesters and Their Applications," Reinhold Publishing Corporation, New York, N. Y., 1957.

4 H. Lee and K. Neville, "Epoxy Resins, Their Application and Technology," McGraw-Hill Book Co., Inc., New York, N. Y., 1957.

5 H. Simonds, "Source Book of New Plastics," Reinhold Publishing Corporation, New York, N. Y., 1959.

6 R. H. Sonneborn, "Fiberglas-Reinforced Plastics," Reinhold Publishing Corporation, New York, N. Y., 1954, pp. 15–20.

7 B. M. Vanderbilt, *Modern Plastics*, vol. 37, Sept., 1959, p. 125.

8 P. Morgan, "Glass-Reinforced Plastics," Philosophical Library, Inc., New York, N. Y., 1954, pp. 117–140.

9 G. Sorell, *Chemical Engineering*, vol. 666, March, 1959, p. 154.

10 F. W. Jassen and J. N. Howell, *Trans. AIME*, vol. 213, 1958, p. 81.

11 *Modern Plastics*, vol. 35, June, 1958, p. 105.

12 W. H. Sharp and M. K. Weber, *Corrosion*, vol. 12, February, 1956, p. 71t.

13 H. D. Boggs and E. D. Edmisten, *Corrosion*, vol. 14, May, 1958, p. 114.

Attention, pilots: Trainees on the new jets must learn new techniques; the swept wings introduce roll tendencies never before experienced to the same degree. Engines respond differently. Handle with care.

Piloting the Jet

SWEPT-WING jet transport airplanes exhibit behavior that is a complex combination of the effects of turbine-engine characteristics, the location of these engines, the inherent C_L/C_D characteristics of the swept wing, and the characteristics of tab-flown aerodynamic controls and spoilers which are used as lateral-control devices.

There is no easy explanation of the complex relationship between the cause and effect of these combined characteristics. Careful analysis and appreciation of these characteristics are essential for a satisfactory understanding of the flight characteristics and behavior tendencies of swept-wing airplanes.

The most important part of the closed circuit—airplane behavior, pilot notification, pilot action, airplane response—is the pilot himself. He must know and understand not only the inherent characteristics of his airplane, but also the type of warning or lack-of-warning it possesses, and he must be triggered or spring-loaded to take the proper action at precisely the right time; otherwise, it may be said of him that he never learned that "this sweetheart of an airplane, this Queen Mary of the airplanes can be very unforgiving."

Turbine Engines

To date, the airplanes introduced in air-carrier operation have been equipped with the Pratt & Whitney JT3/JT4 and General Electric CJ805 engines which possess very similar characteristics. The main difference in the Pratt & Whitney engines is the water-injection features of the JT3. The CJ805 exhibits a different response rate and is handled differently with respect to power settings. Although the response rate of these engines is considered to be good, the perception of thrust is much less apparent than with the reciprocating engine. This feature has resulted in the pilot lagging the thrust requirements of the airplane.

Coupled with this problem of "feeling" thrust changes is the difference in airplane response to thrust changes. With the propeller airplanes, added thrust immediately improves lift because of the induced flow across the wings from the propellers. With the jet, it is necessary to increase speed of the airplane to achieve increased lift.

During landing approach, this can cause an incipient undershoot. A portion of the noise problem in the airport approach lane has been caused by the failure to

[1] Flight Test Inspector, Flight Test Branch, FS-160.

[2] As this paper was being prepared for publication, news came of the loss of a jet airliner on a training flight near New York (January 28, 1961), an accident that may well be explained by the facts presented here—EDITOR.

Contributed by the Aviation Division and presented at the Winter Annual Meeting, New York, N. Y., November 27–December 2, 1960, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Condensed from "Special Pilot Considerations for Swept-Wing Jet Transports," Paper No. 60—WA-268.

By Walter Haldeman[1] Federal Aviation Agency, Washington, D. C.

Transports[2]

apply sufficient thrust soon enough when getting low on the glide slope, or when getting slightly below the target approach airspeed, and the subsequent necessity to use high thrust to recover. The "too low and slow" situation is partially brought about by the flap-extension rate and the tremendous inertia of the airplane which cause the speed to bleed off slowly; but once the flap drag has increased materially, the drag and inertia make it time-consuming to regain speed or regain flight path. The need for additional thrust must be anticipated early and applied promptly.

The last 10 deg of flap deflection on these airplanes result primarily in an increase in drag. When full landing flap is commanded, we should have speed to bleed off, altitude to lose, or the aircraft committed for a landing (or touch and go). Otherwise, we can find ourselves low and slow with full take-off power required.

The thrust/time characteristics of these engines must be understood and respected. Fig. 1 is a plot of per cent thrust versus time to bring a typical engine up to thrust and to reduce thrust.

On all of our turbojet airplanes, the pod-mounted engines are displaced laterally in selected locations to provide favorable wing bending and dynamic characteristics. These considerations dictated the placements of engines 1 and 4 at a relatively greater distance from the fuselage than was the case with piston-engine airplanes.

In order to handle the unsymmetrical thrust condition, more effective lateral and directional controls are required to achieve the low values of minimum-control speeds necessary for low engine-failure decision speed (V_1) associated with the minimum takeoff-runway distance requirements.

Sweptback Wing

The difference between the flight characteristics of a swept wing and a straight wing can be shown by examining the slope of the lift curve, C_L, for these two wings. Fig. 2 indicates the need for a higher maximum angle of attack for take-off and landing as sweep is increased.

Essentially the same relationship exists for the angle of attack required to perform a flare and landing in the three types of airplanes. An additional rather important factor shown in Fig. 2 is the increase in the increment of angle of attack in the swept-wing airplane which is necessary to produce the same percentage of C_L increase. This is due solely to the fact that the slope of the lift curve for the sweptback wing and the delta is much flatter. Other features are the difference in angle at the stall, stall characteristics, and the likely difficulty in defining a precise stall speed.

Referring to Figs. 3 and 2, it is noted that the advancing wing in a yawed condition will have a decidedly different lift-curve slope than does the retreating wing. At approximately 10 deg of yaw, the lift curve of the advancing wing would probably look more like the

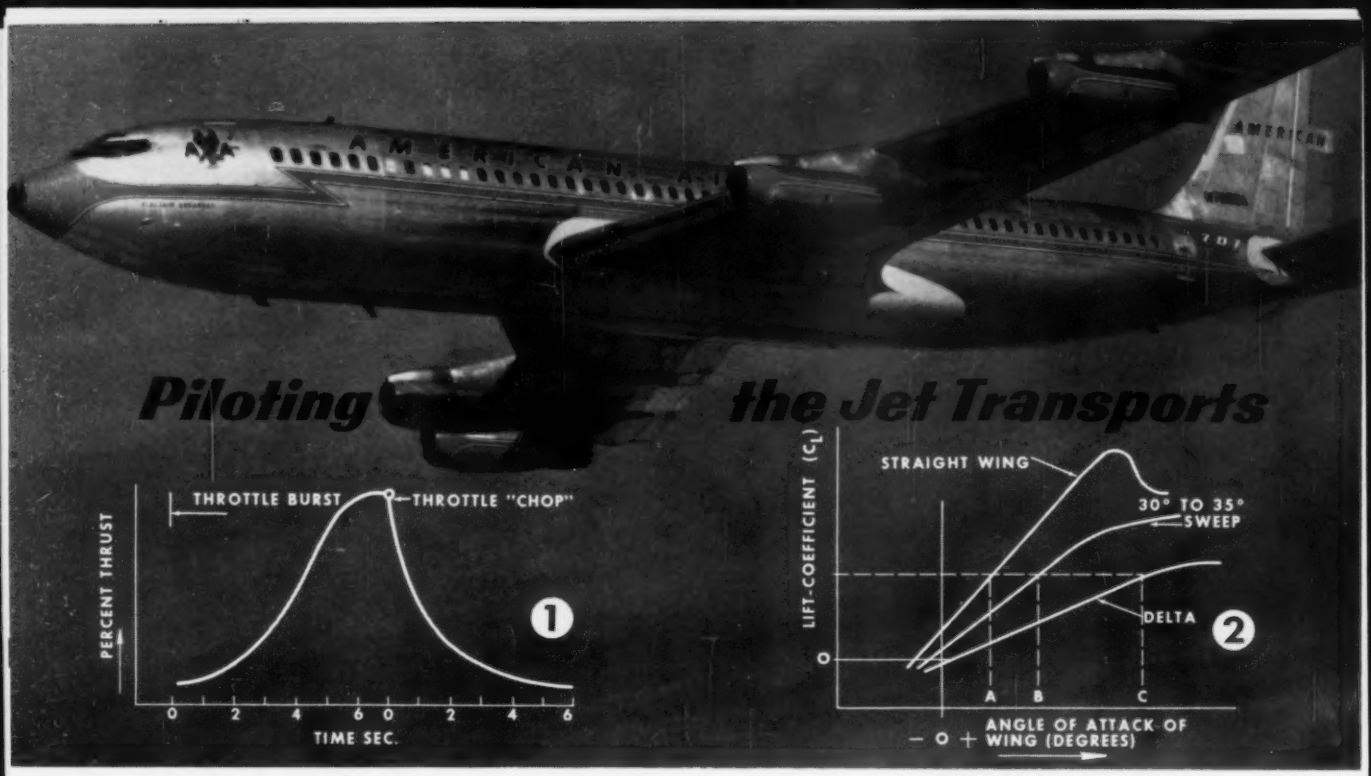


Fig. 1 The need for additional thrust must be anticipated early. Only a slight amount of thrust is added in the first two or three seconds after throttle application. Most of the thrust becomes effective in the last two seconds. In reducing thrust, approximately 50 per cent is lost in the first two or three seconds, immediately after the throttle is pulled back.

Fig. 2 The required take-off angle of attack will be quite different for the straight-wing airplane **A**, the 30 to 35-deg swept-wing **B**, and the delta-wing **C**. Essentially the same relationship exists for flare-out.

straight-wing airplane in Fig. 2, and the retreating wing would have a lift-curve slope similar to the delta.

The result of this difference in lift versus yaw, at a given airplane angle of attack, is to produce a roll which will vary in magnitude with the amount of yaw introduced.

This description should give one sobering thought when contemplating a yawed (or sideslip) condition with unsymmetrical thrust at low speed. This can produce a powerful rolling moment.

With symmetrical thrust, if yaw is introduced by rudder application, the resulting tendency to roll must be restrained by opposite aileron application.

Dutch Roll

If an airplane possesses even a minor long-period directional oscillation, a neutrally stable yaw/roll couple will develop. This type of oscillation, possibly because of the resemblance to the lazy roll of a Hollander on ice skates, has inherited the name "Dutch roll."

The small-magnitude undamped directional "hunt" of an airplane was originally referred to by pilots as "short-period oscillations." The length of time associated with the oscillations increases with airplane size; it becomes a long-period oscillation with the big jets. This "hunting" may be of such small magnitude that it is difficult to detect by visual reference over the nose.

In view of the fact that swept-wing airplanes have an inherent tendency to roll with yaw (or if you prefer to think of it as a skid), and further, because these airplanes possess high roll capabilities with lateral-control application, it is quite evident that the coupling of lateral-control application with a roll tendency that results from yaw can greatly amplify the roll rate. In such a maneuver if rudder is also coupled with improper control to the extent that additional skid is added to the inherent yaw, a roll rate considerably greater than the structural limits of the airplane can be developed.

Such a maneuver is reported to have occurred in one training accident and the surviving pilots reported that it had all of the appearances of a "snap roll." The lateral acceleration on the pods in a pilot-airplane-coupled roll of this type can exceed 6*g*.

In the initial indoctrination flights, it was noted that attempts to fly these airplanes smoothly at high C_L would result in a slowly increasing low-amplitude lateral oscillation. It became apparent that this was a pilot-coupled maneuver, for each time this condition was observed, it was noted that aileron application was lagging behind the lateral oscillation, such as to be in phase with, or additive to, the inherent roll-with-yaw tendency of the airplane; thus the magnitude of the Dutch roll continued to increase.

It was also noted that a little rougher pilot technique, or "taking the bull by the horns," stopped this maneuver promptly by an aileron application, the rate of which was out of phase with the natural lateral mode of the airplane.

Investigations of the various techniques to arrest Dutch roll show that it can be accomplished by using the rudder to arrest the yaw, which is introducing the roll, or by the technique of positive, firm lateral-control at a rate different from the normal oscillation period.

The reason for requiring pilots to demonstrate recovery from Dutch roll is that a trainee pilot may precipitate an increase in roll rate by inadvertently getting in phase with the airplane's natural mode.

Fig. 3 A swept-wing airplane in yawed flight. The advancing wing would have a lift curve like that of a straight-wing plane, while the retreating wing's lift curve would resemble that of the delta. This can result in a serious roll tendency.

Fig. 4 Airflow changes at the critical Mach number; the flow separation that occurs behind the shock wave. **Above,** the center-of-pressure shift that occurs with the onset of separation in the inboard section of the wing, a shift not only outward, but to the rear of the originally "trimmed" position, causing "tuck," or nosing down.

High Dynamic Speeds and Compressibility Effects

At high Mach numbers, the compressibility effect of the air results in a change to the boundary layer which produces a change in the chordwise and spanwise center of pressure of the wing.

It will be noted that we use the expression "high Mach number" because the Mach number at which this phenomenon occurs will vary with wing profile, wing sweep, and planform. This speed has been called the Mach critical speed for the surface.

Fig. 4 shows that, with the onset of separation in the Mach critical inboard section of the wing, the spanwise center of pressure moves outboard from *A* to *B* to what might be called the effective mean aerodynamic chord.

It will be noted that as the center of pressure moves outboard, it also moves aft, resulting in a slight downward pitching moment to the nose because the resultant center of lift is now aft of the position for which the airplane was originally trimmed.

This is a rather simplified but generally correct explanation for the cause of "tuck," or nosing down.

In the initial discussion and flight-test phase of the turbine transports, considerable concern was evidenced regarding the suitability of the small speed spread between the normal-operation speed, the never-exceed speed, and the demonstrated dive speed in the Mach critical altitude range. The first attempt, however, to achieve high Mach speeds will convince anyone that the compressibility buffet, the considerable dive angle required, and the rapid altitude loss are proof that the "drag rise" is a real and practical deterrent to inadvertent overspeeds.

In the altitude range in which the maximum certificated speed is limited by design considerations of dynamic pressure and not Mach effect, safe speeds can be exceeded quite easily in level flight or with a light airplane in a climb. For this reason, aural speed-warning devices were incorporated in all jets and are programmed to activate at the never-exceed speed.

Of course, if the Mach trim device is not operating and the speed-warning bell has malfunctioned, it is possible for an unattended jet transport to get into tuck, possibly by passenger movement, and thereafter lose altitude at a rapid rate, but yet without exceeding a safe Mach number. If inattention is carried too far or if recovery control is not applied until after the airplane descends through the 23 to 25 thousand-foot level, V_{NE} will be readily exceeded and structural damage can be encountered during the application of the accelerations necessary to check the dive.

The planes' tuck characteristics do not comply with the pilot or CAR required stability qualities. Therefore it was necessary for the manufacturers to develop and incorporate stability devices which respond to and are programmed for Mach number and which automatically retrim the airplane on a Mach schedule in the high-speed range.

The "yaw damper" is another device employed for stability augmentation. The directional mode of the autopilot is used for this purpose and, in effect, the yaw damper is a single-axis autopilot with limited authority. It resists pilot effort to move the rudder; therefore it is normally deactivated during take-off and landing.

The yaw damper's prime function is to prevent the very small amounts of yaw (which are almost imperceptible unless reference is made to the turn-and-bank indicator). The yaw damper prevents the uncomfortable Dutch roll. The yaw damper is not considered to be an essential

Piloting the Jet Transports

part of the required equipment of the airplane as is the Mach-trim device. It is more of a convenience item which relieves the pilot of the necessity of monitoring the controls for passenger comfort.

Training Incidents and Accidents

Training incidents and accidents fall into five categories as follows:

1 Stalls with unsymmetrical thrust.
2 Excessive rolls and spins with and without unsymmetrical thrust.
3 Excessive rates of sink during landing.
4 Excessive speeds.
5 Dutch rolling cases on take-off or landing.

The first incident of stall with unsymmetrical thrust was sufficiently violent as to cause damage to the aircraft. The airplane was on a training mission and the trainee pilot was practicing directional control exercises which are intended to acquaint him with the rudder and aileron control required in the case of the loss of an outboard engine while drawing wet take-off power. This condition can be simulated by idling two engines on one side and drawing maximum continuous power on the opposite engines at an altitude of approximately 10,000 ft.

At the weight at which the airplane was being flown at the time of the incident, the minimum control speed of the airplane is below the stalling speed. It therefore follows that the minimum control speed cannot be reached because the stall will occur first; when the airplane becomes stalled the predominant force vector comes from the operating engines and the airplane will begin the yaw-roll maneuver. Unless the throttles of the operating engines are immediately retarded and prompt stall-recovery-control applied, it is natural for an airplane placed in a stall in this configuration to enter a rotating gyration and progress into a spin. Once the yaw-roll gyration is developed fully, the rotation rate in a swept wing can be quite severe, and one engine pod was thrown from the airplane in this incident.

During the type-certification flight-test program, company pilots and Federal Aviation Agency pilots investigated the 10,000-ft one-engine-out simulated condition; and on two occasions, the investigation was carried on into the stall. In both of these cases, recovery was effected without loss of altitude or the precipitation of a spinning maneuver by promptly retarding the thrust levers for the operating engines and easing off on the elevator. In this manner, the resulting roll was confined to 20 to 30 deg.

Consider the effects of allowing relatively large angles of sideslip or yaw into the operating engines to develop at speeds appreciably above the stalling speeds.

During simulated two-engine-out approaches, the rudder force required can become quite tiring if rudder trim is not used. If the rudder force is relaxed, the pilot may instinctively increase the aileron control to maintain heading. This action increases the yaw. If the rudder is relaxed sufficiently or if the airplane is banked excessively into the operating engines, yaw angles can develop which are beyond the capabilities of the lateral control, and the airplane will enter a dynamic maneuver in which roll with yaw occurs. If yaw angles greater than approximately 10 deg are allowed to develop by releasing rudder, attempts to check the dynamic roll by reapplying the rudder will not be successful, since the yaw moment resulting from the two operating engines exceeds the combined lateral and directional control effectiveness. Yaw angles in excess of 10 deg materially reduce the angle of attack of the rudder tab and thus its effectiveness in moving the rudder for directional control.

In such a maneuver the pilot must immediately reduce thrust on the operating engines, for the dynamics of this situation should readily indicate that lateral and directional control will not be sufficient to override the effects of asymmetrical thrust.

There have been a number of cases on training flights wherein the two-engine-inoperative condition is being flown, where the pilot relaxed rudder and, in order to maintain the desired heading, applied additional aileron up to its limit. In several such cases, the airplane has rolled to various degrees, including "onto its back" when large sideslip angles developed.

One case which resulted in an accident appears to have been a coupling of sharply applied control forces with the airplane yaw-roll modes during practice in arresting Dutch roll.

In this case, the maneuver resembled a snap roll and resulted in shedding of engines one, two, and four.

Although control was regained and the airplane flown some distance on the remaining engine, it was lost in the ditching operation.

Excessive rates of sink: The tremendous inertia of these large airplanes is such that, once a high rate of sink is developed, there must be time to flare, and/or additional speed is required to change the flight path.

The slope of the lift and drag curves and the response rate of the engines dictate that high rates of sink should not be allowed to develop during approach or should be checked early and at a comfortable altitude, otherwise an undershoot or severely hard landing will result.

Excessive speed: In only one case of excessive speed has there been any structural damage. In this case, it was of a minor nature and fortunately did not prevent the airplane from continuing to destination. Passenger movement can cause a speed change and, if the speed-warning device is not operative, the airplane will go into tuck if the stability augmentation is off. This buffeting can resemble turbulence and, if the speed is not checked before reaching lower altitude, the airplane will exceed design speeds.

Dutch roll on take-off: A number of cases of striking a pod on take-off or landing, although of no serious consequence to date, indicate a need for understanding of the lateral response rate and practice in arresting the low-amplitude roll-yaw condition.

This first installment covers friction and wear, boundary lubrication, metalworking lubricants, and automotive lubricants. Studies of friction at high velocities are producing new data on such problems as temperature effects in sliding, and formation of oxides.

LUBRICATION REVIEW

Friction and Wear

By M. B. Peterson[1]

DURING this review period, the papers which were presented at the London Conference in 1957 were published [1][2] by the ASME and have been reviewed [2, 3]. Several other review papers have also been published. Crook [4] describes experiments at Aldermaston which define the wear process more clearly as well as various studies in lubrication. Bowden [5] summarizes recent work on the frictional characteristics of wood, diamond, glass, rubber, and metallic carbides as well as high-velocity sliding studies at Cambridge. The flash-temperature theories of Blok, Jeager, Bowden, and Thomas and Holm have been reviewed by Archard [6] with particular emphasis on the physical aspects upon which the calculations are based. The temperature equations are given for stationary heat sources, slow-moving and fast-moving sources; the methods for choosing between them are also given. Graphical means are presented to determine θ_{max} from the load and the velocity. The results are applied to the wear of steel and polymers.

In friction fundamentals, Tabor [7] has reviewed and extended the junction-growth concepts. This is an extension of the adhesion theory which takes into account the combined normal and tangential stresses. Using the equations for plasticity of a two-dimensional solid sliding on a rigid surface derived bv Nadi, Tabor shows that the area of shear must increase as a result of the combined stresses. The basic equation of the junction growth is found to be

$$p^2 + \alpha s^2 = P_0^2$$

Substituting $p^2 = \frac{W^2}{A^2}$, $s^2 = \frac{F^2}{A^2}$, and $P_0^2 = \frac{W^2}{A_0^2}$

gives the equation

$$1 + \alpha\phi^2 = \frac{A^2}{A_0^2}$$

where p = normal pressure, s = shear stress, P_0 = yield pressure, α = constant, W = load, F = friction force, A = area of contact, A_0 = original area of contact, S_i = shear strength of interface, σ_3 = constant, and where $\phi = F/W$. This equation is shown to fit the experimental data quite well. The junction growth will continue until $\frac{F}{A} > S_i$ and the coefficient of friction at slip is given by $\phi = \frac{1}{3\left[\left(\frac{S_i}{S_m}\right)^{-2} - 1\right]}$. The ratio S_i/S_m represents the reduction in junction strength due to surface films. Rubenstein [8] has modified the junction-growth equation for a work-hardening material. Considering that, since the stress-strain curve is the locus of yield point with increasing strain, and that $p_0 = \sigma_3 A^{x/2}$, where x = work-hardening index, the junction-growth equation then becomes

$$W^2 + \alpha F^2 = \sigma_3^2 A^{2+x}$$

A semiempirical equation for indium is derived which gives excellent agreement with experiments. The load-dependence of friction is thus attributed to the fact that the material in the contact region is incompletely work hardened when slip occurs.

Further work has also been reported on defining the static area of contact. Kraghelsky and Durkin [9] have defined the area of contact as the design area, the ap-

This Review covers the period January 1, 1959, to June 1, 1960.

[1] Physicist—Friction and Wear, General Electric Company, General Engineering Laboratory, Schenectady, N. Y.

[2] Numbers in brackets designate References at end of paper.

Contributed by the Lubrication Division and presented at the Annual Meeting, New York, N. Y., November 27–December 2, 1960, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Prepared by Subcommittee B, Paul Lewis, Chairman of the Digest Committee.

The "Digest of 1958 Literature" on lubrication appeared in MECHANICAL ENGINEERING, October, 1959, pp. 56–69.

Developments in Bearings and Lubricants
A Digest of the Literature for 1959-1960

parent area due to the deformation of surface waviness, and the real area due to the deformation of asperities. Experiments using optical methods confirm the results of Archard and Hirst; an increase in the real area is due to increasing the number of contacts rather than increasing the area of each contact. A discussion of each type of area of contact and the effects of various parameters on that area is given. Single contacts of truncated cones are treated, and the results are extended to multiple-asperity contacts. A good correlation is obtained between the calculated values and observed values for certain materials. Rabinowitz [10] has also considered the area of contact of two solids and has defined a fourth area, the true area, which represents that part of the real area where there is a bond formed between the materials.

Along somewhat similar lines, Iwaki and Mori [11] have considered the change of roughness when a rough surface is pressed onto a mirror surface and another rough surface. The changes in roughness, gap, area, and distribution are considered as affected by the pressure and the relative hardness of the materials.

Ling and Lucek [12] have considered the dynamic contact of single asperities. The normal force and the friction force are continuously measured as two cones (representing a single asperity pair) are brought through contact. The effects of cone angle, misalignment, and presence of a lubricant are discussed. It is shown, for example, that the friction is insensitive to the presence of a lubricant when the cones are in line, but a lubricant effect is noted when they are out of line. Further, the friction decreased as the cone-angle decreased.

Experiments on adhesive have been carried out by Anderson [13] to test the adhesion theory of friction. Cylinders of material are loaded axially against each other, twisted, and the force to separate them is measured. The coefficient of adhesion γ (ratio of the force to separate to the normal load) is measured. It was found necessary to obtain a statistical distribution of γ to obtain $\bar{\gamma}$. For copper $\bar{\gamma} = 0.96$. $\bar{\gamma}$ is also found to be independent of applied load and apparent area of contact. Since these same friction coefficients and laws are found to be true for sliding, it is concluded that friction and adhesion are interrelated phenomena. A discussion of adhesion is also given by Manson [14]. Concepts of dislocation theory are given to account for the time and temperature effects on γ. The effect of atmosphere on adhesion and metal transfer has been considered by Coffin [15]. It is found that in inert atmospheres nickel will slide effectively against sapphire. When oxygen is present, however, metal transfer and damage result. Gold, however, is effective in all atmospheres. Thus it is shown that—depending upon the particular combination—surface films, in this case oxides, form the bonds which facilitate transfer. A similar effect of oxygen also has been studied by Benjamin and Weaver [16, 17]. The adhesion of films formed by vacuum evaporation has been studied by drawing a rounded pointer across the surface of the evaporated film; the load is gradually increased until the film is removed. The results indicate that iron and aluminum are both strongly bonded to glass by an intermediate oxide layer; gold does not form this layer and is held by Van der Waals forces only. Since a time effect is observed, it is felt that the oxide layer can be formed by oxygen diffusion to the interface.

Another factor which should be considered as part of the friction force has been elaborated upon by Bueche and Flom [18]. In experiments with lubricated sliding of metals on polymers over a range of speeds and temperatures, it is shown that a correlation exists between frictional behavior of materials and their bulk mechanical properties.

Because of the conditions imposed by high-speed flight, temperature effects in sliding have received considerable attention. A study was made of the sliding characteristics of pure metals at temperatures to 1600 F by Peterson, Florek, and Lee [19]. It was found that friction was reduced at a temperature sufficient to promote oxidation of the surfaces. The temperature where this occurred is given for the following metals: Co—80 F, Fe—100 to 200 F, Cu—400 to 500 F, Mo—800 F, Cr—800 F, Ni—1200 F. Several of the oxides which would be formed on these metals were found to be effective lubricants at high temperatures. It is hypothesized that the most effective sliding will result when metals are used which form soft oxides. It is also shown that there is a correlation between the frictional properties of the pure metals and alloys which contain them as major constituents. A similar effect was reported by Buckley and Johnson [20]. In a study to clarify the role of silicon in alloys used for sliding contacts at high temperatures, experiments were conducted with Si–Ni alloys in which the Si content was varied to 10 per cent. The results indicate that the improved friction and wear cannot be due to hardness. The important effect is its role as a film former. With low silicon content its beneficial effect was attributed to the formation of a viscous film, with high silicon content to the smearing of the softer α Si Ni over the harder β Ni_3Si. The effect of a molten oxide film was noted by Zeeman and Coffin [21]. With B_4C sliding at temperatures above 1400 F, a molten B_2O_3 film was formed at the sliding interface which yielded hydrodynamic lubrication at higher velocities. More generally, Zeeman and Coffin consider the sliding characteristics of refractory compounds at temperatures to 2000 F in order to determine if the theories developed for the selection of metal couples are applicable. The effects of solubility, reaction, hardness, and shear strength are considered. It was concluded that solubility and hardness were important criteria. However, these effects could be masked by microfracturing at the interface. Various lubrication schemes were also considered. The friction and wear of metals to 1000 C was considered by Kingsbury and Rabinowitz [22] using the metals—zinc, copper, titanium, and 1020 steel. At room temperature the friction and wear of steel were dependent on the partial pressure of H_2O, decreasing as the partial pressure rose. Except for steel the friction was essentially constant with increasing temperature. However, the wear rate increased. The results are discussed in terms of the surface energy and the hardness.

Friction experiments at 300 and 600 F by Miller [23], investigated the effects of load and pressure over a broad temperature range, and the influence of surface form. The sliding characteristics of $MoSi_2$ were investigated by Rowe [24] with sintered bars and with $MoSi_2$ coatings formed on pure molybdenum by vapor deposition. It is shown that $MoSi_2$ does not seize during sliding but yields high friction ($f_{28C} = 0.7\ f_{>700C} = 1.4$). Films of

$MoSi_2$ on Mo are shown to be effective in preventing surface damage.

High-temperature lubrication schemes have been considered by a number of investigators. Denny [25] reviews the properties necessary for a good bearing material and applies these principles to suggest bearing materials for elevated temperatures. Materials which form immiscible oxides are suggested. Materials which form decomposable oxides are suggested to provide oxygen at the interface. Metal-glass composites are suggested where the glass acts as the lubricant. Low-melting-point oxides are suggested which may lower the glass temperature. The use of reactive gases has been studied by Allen, Buckley, and Johnson [26] and by Buckley and Johnson [27]. Here the high flash temperatures cause decomposition of the gas (for example, CF_2Cl_2). The chlorine then reacts with the metal surface to provide a lubricant film which is shown to be effective to 1200 F. MoS_2 films formed on molybdenum by H_2S have been studied by Rowe [28]. Lubrication is effective to 1500 F in vacuum.

High-temperature sliding studies were made to select materials for particular applications. Wagner and Burwell [29] studied the wear behavior of potential cage materials. Alloys containing silver show superior wear properties to conventional cage materials. A study directed toward the development of seal materials was reported by Baskey [30]. Three types of materials were prepared: (*a*) pure refractories, (*b*) refractories with a nickel binder, and (*c*) materials infiltrated with silver. Wear studies were conducted on each class to select materials for further development. Best results were obtained with 90 WB 10 Ni Ag infiltrated material and a 60 Cr N 20 Ni 20 Ag material.

Friction studies were conducted in liquid nitrogen by Wisander, Hady, and Johnson [31]. Sliding experiments were conducted with various metals and nonmetals. The best results were obtained with filled teflon.

Studies at high sliding velocities indicate that the important effect of velocity is to increase the surface temperature. Bowden and Scott [32] studied the sliding characteristics of diamond and glass. Two types of wear were observed. Below a particular value of velocity $(\text{load})^{1/2}$, the diamond damaged the glass; above that value viscous surface flow of the glass was apparent and the damage was less severe. They also found that the wear of diamond was reduced by physical adsorption of water vapor. With metals at extremely high velocities Bowden and Freitag [33] find three types of surface damage—at low velocities normal abrasion; at intermediate velocities high friction where the material behaves like a material of high viscosity; and a molten state at high velocities. They conclude that the adhesion theory is still valid but with two modifications—softening of asperities and the fact that the real area of contact depends upon the velocity with which the plastic deformation can be propagated. Cocks [34] studied the effect of oxide-film formation on the frictional properties of metals at high velocities while Archard [6] has shown that the high wear with a particular polymer occurs at a particular value of $f\,W^{1/3}\,V^{1/3}$. A method of measuring surface temperatures which utilizes thermoelectric voltages between dissimilar metals is suggested bv Vagramyan [35].

The effect of several other variables on friction have also been reported. Friedman and Levesque [36] showed that the coefficient of static friction can be virtually reduced to zero as a result of vibrations between 6 and 42 kc. Savitskii and Zagrebennikova [37] found that forced rotation in pressing experiments resulted in a reduction in the deforming stresses since the rotation caused a weakening of the blocking effect of friction. Cook [38] has studied dynamic friction with particular emphasis on frictional vibration. Theories are reviewed and extended and a stability criterion established. It is pointed out that frictional vibrations can occur when the relative velocity of two surfaces is greater than zero. This is attributed to a decrease in flow stress with increased temperatures for dry surfaces and the effect of the boundary-hydrodynamic transition for lubricated surfaces. Extremely low friction is reported by Tamai [39] at low amplitudes for gold, silver, copper, and platinum. No explanation is given for the phenomenon.

More work has been reported on the frictional behavior of specific materials. Huffington and Stout [40, 41] consider the friction of natural and synthetic fibers. The deformation of single and multiple contacts is considered for different assemblies of fibers.

James [42] studied the surface damage, particularly the formation of "rolls," with polyvinyl chloride sliding on steel. Eisner [43] measures the coefficient of static friction for a number of materials. Large values (>400) were found, for example, for plastic-foam sponge sliding against itself. Denny [44] has studied squeeze film effects with rubber and finds an effect not only of viscosity and surface roughness but also of modulus of elasticity of the rubber. The galling characteristics of nickel-base alloys, both lubricated and unlubricated, were studied by Kozlik [45]. The maximum pressure for each combination is given. The superiority of silicon additives is demonstrated. The friction and wear of titanium are discussed by Miller and Holladay [46]. From their investigation they conclude that titanium is covered with a layer of absorbed gas that reduces friction but does not prevent galling. This film prevents the adhesion of ordinary lubricants and is responsible for the nonadherence of electroplated coatings. They suggest metallic coatings as the best way to provide lubricating surface.

Studies of wear have been limited. Sata [47] has studied the transition observed during initial run-in. He concludes that the transition is due to the transferring of a layer of worn particles from the slider to the track. Steign [48, 49] has carried out a rather elaborate study of wear with a single-pin-and-disk apparatus. He confirms the law of simple wear with the exception that there were periods of low wear in the wear-time curve, attributed to the formation of an oxide film. Some unusual effects, however, were noted when sliding rings were used. For brass surfaces sliding against each other, a ring with slots machined in its surface wore less than the mating ring (no slots). The total wear on both rings remained constant. Furthermore, the discrepancies between the wear of the two rings increase as the geometries of the mating surfaces become more unlike. A study of metal transfer for brass sliding against steel was also conducted. He confirms previous work by Kerridge but does note some back transfer. He also finds different amounts of transfer and wear depending upon the material—more

transfer to a smoother surface and in argon. It is also found that the transfer depends upon the presence of slots in the surface and at higher speeds less wear and transfer occur. Methods of measuring wear in applications is reviewed by Khruschov [50]. Specific techniques for measuring wear with microgrooves are given. He has found that the cut-out microgroove is one of the best methods since there is no surface distortion with this method. Electrical wear in relay contacts is discussed by Germer [51]. The wear of slipping has been studied by Schallanch [52]. Resistance is found to be an important factor in their wear. Dearden [53] gives rail and tire wear under different conditions of operation and the effect of several variables on it. Neibylski, Antler, and Brockway [54] show how electron diffraction may be used in wear studies. In this paper it is pointed out that sliding results in the following fiber orientation on the surface.

HEX Be, Zn, Ti, Zr	001 plane parallel to abrasion direction
FCC Cu, Ag, Au, Pt	110 plane parallel to abrasion direction
BC Fe, Mo	111 plane parallel to abrasion direction

A comprehensive study of this surface orientation with hexagonal metals was made by Scott and Wilman [55]. They find that abrasion of polycrystalline and single-crystal Be surfaces results in fiber orientation with the 001 plane tilted 21 deg ± 4 deg to the plane of the surface. There is also evidence of 001 orientation perpendicular to the surface. Using an etching technique which made the intersection of dislocations with the surface evident, Bailey and Gwathmey [56] found evidence of plastic deformation 150 μ below the surface and well ahead of the sliding track when a sapphire stylus slid against a single face of copper.

A study of abrasion was carried out by Goddard, Harker, and Wilman [57]. Sliding experiments were carried out with Cu, Ag, Pt, Al, Fe, Mo, and W blocks sliding against emery papers with different mean particle-diameter size. A large effect of transferred metal is noted. Expressions are developed for the friction with various particle shapes. They find that for spherical particles the ploughing component is small. The friction of emery papers of different mean particle diameters sliding on each other was studied by Porgess and Wilman [58]. It was found that the main variable part of the friction is a function of the radius ratio. The other portion of friction was due to elastic hysteresis losses. The abrasion and friction anisotropy of diamond was studied by Seal [59].

A study of bench wear tests and their correlation with service was discussed by Robinson, Thomson, and Webbere [60]. Other papers reported but not translated are listed in Refs. [61 to 68].

Boundary Lubrication

By S. F. Murray[3]

THERE is a definite trend in sliding studies toward the consolidation of test data and the establishment of more fundamental criteria for interpretation of the results obtained. However, major emphasis is being placed on dry-sliding evaluations. Attempts to apply the same criteria to boundary-lubricated surfaces are complicated by the fact that the types of metals, the lubricants, the environment, and the experimental conditions must all be factored into any interpretation of the results.

The several areas of specialization in boundary lubrication have been broken down as follows: (*a*) Conventional boundary lubrication, (*b*) extreme-pressure lubrication, (*c*), test equipment and correlation studies, (*d*) machine-way lubricants, (*e*) drawing lubricants, (*f*) fretting.

No attempt was made to include references from the London Conference which have been adequately summarized in [69 and 70].

Conventional Boundary Lubrication. The influence of temperature on the boundary-lubricating characteristics of various lubricants has been the subject of several papers. Cowley, et al. [71] measured the transition temperatures from effective lubrication to failure for several synthetic lubricants. A characteristic failure temperature was found for each lubricant. This temperature decreased with increasing load or speed. A related study by Fein, et al. [72] used fatty-acid additives in pure hydrocarbons. In this evaluation the transition temperature also decreased with load but increased with sliding velocity. It was shown that the reciprocal of the transition temperature varied linearly with the log of the ratio of load to speed. Rabinowicz [73] set up an energy balance for lubricated surfaces sliding in contact which takes into account the fact that there are two transition temperatures. The first is the result of melting of the lubricant film and the second of lubricant desorption and a subsequent increase in the work of adhesion between the metal surfaces. An evaluation of the effect of temperature on additives for babbitt-steel combinations was described by Miller, et al. [74]. Extreme-pressure additives were not effective, but fatty acids added to mineral oil substantially reduced friction over a wide temperature range.

The effect of wear debris on the lubrication of damaged steel surfaces by fatty additives was reported by Tamai [75]. Both friction and contact resistance were used to show that the rough surfaces and wear debris destroyed protective films during sliding. A gradual run-in was observed. High concentrations of fatty additives appeared to be helpful in dispersing the wear debris. Hirano, et al. [76] studied the effects of other contaminating solids such as metals and abrasive particles on boundary lubrication. Metal particles caused abrasion but only affected total wear over the intermediate load range. Hard abrasive particles increased the wear at low loads but at high loads could not penetrate the contact areas. It is interesting to note that the use of solid lubricants such as graphite or molybdenum disulfide required a high solids concentration in the oil before any effect could be observed. An equation was set up

[3] Chemist, General Electric Company, General Engineering Laboratory, Schenectady, N. Y.

to calculate wear as a function of particle concentration, hardness, size, and base-oil viscosity.

Smith [77] made a comparison of the transition from boundary to hydrodynamic lubrication for surfaces sliding in contact and for surfaces rolling in contact but skewed to superimpose a small degree of slip. The same Hertz initial contact stress was used in both cases. Lower frictional forces were measured in the sliding tests. This result was explained as being due to temperature rise and a subsequent decrease in the shear strength of the lubricant film.

Miller, et al. [78] reviewed the published work on the lubrication of titanium.

Some light was thrown on the problem of assigning a lower limit to frictional force by references [79 to 81]. A relationship between the frictional properties of materials and their elastic hysteresis losses was demonstrated by Bueche, et al. [79]. These elastic losses are frequency and temperature-dependent and are related to molecular properties. Rubenstein [80] has shown that the use of a lubricant under loads where large-scale penetration of the lubricant film does not occur will result in the coefficient of friction being load-dependent. By neglecting welding or metallic contact between sliding surfaces and assuming that only molecular forces between hydrocarbon layers were important, Cameron [81] calculated coefficients of friction which were of the same order as those normally measured in boundary-lubrication studies.

Coffin [82] studied the lubricating characteristics of NaK, spindle oil, water, xylene, and so forth. Careful choice of bearing surfaces allowed the bearings to wear in smoothly and resulted in hydrodynamic lubrication.

Extreme-Pressure Lubricants. Bennett [83] and Loeser, et al. [84] studied the behavior of extreme-pressure additives, specifically zinc dithiophosphate. In [83] radioactive phosphorus was used to determine the effect of operating conditions on the formation and durability of these reaction films.

The use of molybdic xanthates and molybdenum blue as lubricant additives was investigated by Hugel [85]. Beneficial films were obtained and some efforts to optimize the lubricant blend by the addition of a small amount of a detergent compound were described. Niebylski, et al. [86] attempted to identify the structure of the films formed by the molybdenum xanthate. Their results indicated that the reactions were fairly complex.

Test Equipment and Correlation Studies. Robinson, et al. [87] described the correlation obtained between two types of bench-test equipment and field results for automotive applications. An extensive bench-test program on turboprop oils was reported by White [88]. Many synthetic oils gave better wear results than conventional mineral oils. A "nut-cracker-type" sleeve-bearing test machine was described by Fazekas, et al. [89]. Some bench-test results on fluorinated esters were presented by Ballard, et al. [90].

An interesting and unusual problem involving the lubrication of wooden ways for launching ships was described by Clark, et al. [91].

Machine-Way Lubrication. Some of the difficulties involved in applying bench-test data on boundary lubrication to the sliding characteristics of machine-tool ways were emphasized in many of these references. The major problem is the fact that both boundary and hydrodynamic lubrication phenomena are involved in these applications and different criteria must be applied in each region.

Birchall, et al. [92] studied the effect of surface finish and oil viscosity on friction and stick-slip. A variety of metals and plastics were evaluated by Weiter, et al. [93]. The relationship between the time at rest and the static friction was emphasized. A more detailed study of the effect of rest time on the coefficient of static friction of elastomers was presented by Denny [94].

Conn [95] described some of the problems and methods of alleviation of stick-slip phenomena in machine-tool ways. Some observations on the effect of surface finish and run-in on the sliding characteristics of cast-iron alloys were described by Moore [96].

Drawing Lubricants. This is a very specialized area in the field of boundary lubrication which is characterized by extremely high loads and severe deformations of the underlying surfaces.

Lancaster, et al. [97] studied the results obtained when surfaces were extended by less than a few per cent as compared with reductions on the order of 60 per cent. It was shown that loss of the lubricant film rather than the high loads was the major source of difficulty. Grit blasting the test-specimen surfaces provided lubricant pockets to act as a source of resupply. The problem of drawing aluminum was discussed in detail by Petronio [98]. Pretreatment to provide a porous surface to hold the lubricant was as important as the drawing lubricant. The best results were obtained with an oxide pretreatment and a sulfurized lubricant covering a dry-soap film.

An oxalate coating similar in properties to a phosphate film was also described [99]. Eary [100] demonstrated the use of statistical methods in interpreting the results of press-drawing cold-rolled steel with several popular lubricants. A review of wire-drawing fundamentals was given by Wistreich [101].

Fretting. The effect of running specimens of varying hardnesses submerged in lubricant was described by McDowell [102]. Under these conditions, oxidation of the wear debris was minimized but galling of the surfaces occurred. The use of extreme-pressure lubricants did not help. Hardening the surfaces per se did not offer any solution to the problem, but nitrided surfaces gave good results.

Metalworking Lubricants

By A. F. Gerds[4]

Metal Forming. Much of the recent research literature on metal forming was concerned with wire drawing. Wistreich [103] in a good summary article described the functions of lubricants in wire drawing. Ideally, the lubricant should completely separate the wire from the die. In a subsequent article [104] he gives practical and economic means of drawing wire much more rapidly

[4] Consultant, Metalworking Research Division, Battelle Memorial Institute, Columbus, Ohio.

Developments in Bearings and Lubricants

than is common at present using newly developed pressure dies. Lancaster and Rowe [105] found that grit blasting the surfaces of steel bars, prior to slow drawing under heavy loads, minimized the breakdown of the lubricant in drawing. Collins [106] discussed the use of Borax as a lubricant carrier in conjunction with soap lubricants as an aid in drawing steel wire. White and Miller [107] found that chemical conversion coatings, such as fluoride-phosphate and sodium hydroxide, used in conjunction with lubricants containing molybdenum disulfide, permitted the successful drawing of titanium wire. Stoddart [108] reported that lubricants containing animal fat, soap, and rape-seed oil are useful for drawing copper wire at high speeds (6300 fpm) when used with large volumes of coolants to dissipate heat. Veiler and Likhtman [109] state that the effectiveness of lubricants when working metals under pressure depends on the formation of a very thin plasticized layer of the deformed metal and surface-active lubricants.

Petronio [110], studying the deep-drawing of aluminum-alloy cartridge cases, found that conditioning the metal surface by anodizing, phosphating, or coating with dried-on soap films is equally as important as liquid lubricants. The instability of austenitic materials was used by Wiegand and Kloos [111] to measure the effectiveness of different lubricants in the deep-drawing of austenitic alloys. Eary [112] used a statistical method to study the effectiveness of press-drawing lubricants in a cupping operation on sheet metal. He found that chlorinated wax and medium-pigmented lubricants were effective lubricants for this operation.

Leclerc and Buffett [113] found glass to be an effective lubricant for extruding high-quality bars and tubes of zirconium and Zircaloy 2. Grindrod [114] reported that glasses were the most effective of over 200 materials studied to protect titanium alloys during hot-forming and subsequent heat-treatment. According to Wikle [115], glass or salts are also effective lubricants for extruding beryllium between 1250 F and 1500 F; graphite and molybdenum disulfide are effective below 1250 F.

Jaoul and Sejournet [116] studied the effects of lubrication in the hot-forming of steel by simple compression, deep-drawing, and extrusion. Wilcox and Whitton [117], using high-purity aluminum, developed an equation by which the pressure and optimum die angle can be predicted for extrusions over a range of extrusion ratios up to 150:1.

Whetzel and Rodman [118] determined the friction coefficients of over 400 lubricants for cold-rolling thin strip steel. Oily liquid chemicals soluble in water were outstanding lubricants for this purpose. Lueg and Funke [119] found that natural fats, made up of long-chain saturated fatty acids, were better lubricants for cold-rolling steel than mineral-base oils and emulsions. Grebenshchikova and Kukarskikh [120] determined that the residual surface film of a lubricant containing castor or cotton-seed oil in addition to talc and ammonium chloride did not result in carbon diffusion into and consequent carbide embrittlement of stainless steel during heat treatment as did films of lubricants used previously.

Metal Cutting. Shaw, Cook, and Smith [121] made a rather extensive study of means of measuring the cooling characteristic of cutting fluids. They found that the chip curl has a great effect on the cooling action of cutting fluids. Shaw [122] explained the function of carbon tetrachloride, a chemically active fluid, in improving the metal-cutting process at low speeds. He found that the vaporized fluid penetrates into the fracture zone at the tool tip and reacts with the freshly cut steel to form a smooth surface covered with iron chloride ($FeCl_3$), a solid lubricant having high-shear strength. Barber [123] discussed the characteristics of modern soluble cutting coolants under different machining conditions.

Clouse and Hall [124] described a method for evaluating cutting fluids using an upright, power-fed drill press. Ten Horn, Schuermann, and Slaats [125] pointed out the importance of selecting proper cutting fluids to maintain dimensional tolerances and extend tool life in reaming operations by eliminating built-up edges on reamers. The use of liquid carbon dioxide as coolant was reported [126] to result in substantial saving in thread-cutting operations by permitting higher speeds, less tool wear, and less tool breakage.

Pahltzsch and Magnussen [127], in a systematic study of belt-grinding lubricants, found that lubricants decrease the size of grinding scratches, remove heat, reduce friction, and prolong the life of grinding belts.

Automotive Lubricants

By J. M. Cunningham[5]

THE research, development, and evaluation of automotive lubricants are continua. Although the prior literature was exhaustive on those aspects of automotive lubricants, the literature of 1959 and the first half of 1960 was equally extensive. Papers relating to lubricants and lubrication of transmissions and two-cycle small engines were in the majority.

General. Modern automotive lubricants are specifically formulated to meet the increased severity conditions of loading and temperature in current engines, transmissions, and rear axles. By contrast, an old lubricant of the early Nineteenth Century was compounded of honey, sheep's blood, and hog's lard by a William Blew [128] for the lubrication of the gudgeons of church bells.

Bartleson [129] reviewed the changing demands on motor oils from 1932 to the present. He pointed out the areas of increased severity caused by the introduction of alloy bearings, engine-cleanliness demands, hydraulic valve lifters, increased compression ratio, and higher power. A typical oil to meet these requirements will contain about 16.5 per cent chemicals and 83.5 per cent petroleum. Improvement of anti-O.R.I. additives, cold sludge depressants, and antiwear additives will be emphasized in the future.

Scientific Lubrication [130] reviewed motors oils from 1949 to 1958 with regard to changing requirements of equipment and the practice of engine operation in Britain.

Lyman and Kavanagh [131] discussed progress over the

[5] Engineer, Group Leader, Gulf Research and Development Company, Pittsburgh, Pa.

past 10 years in the development of lubricating oils containing additives for use in various automotive engines. Authors reviewed the basic research on mechanism of actions of detergents, antioxidants, VI improvers, and polymeric ashless detergents; and indicated the economic significance of the improvements in lubricating oil.

Floyd [132] discussed development of an all-purpose line of lubricants for different makes of two and four-cycle gas engines. Work was based upon extensive field tests involving numerous models of many machines and considered data from builders, lubrication engineers, and customers' engineers.

Lubrication problems of two-stroke small engines were outlined in *Scientific Lubrication* [133], and plug fouling was indicated as the most important from the customers' point of view because an operator would be more interested in running trouble-free than in preventing cylinder wear and piston lacquering.

Haas [134] discussed the lubrication theory and lubricant requirements for air and water-cooled 2-stroke cycle engines of the type used in scooters, outboard motors, power lawn mowers, and chain saws. Lubricant requirements considered film strength, deposits and residue, detergency, anticorrosiveness, and miscibility with gasoline. History of present lubricant was reviewed, and a preliminary specification for a lubricant was proposed.

Lubrication of inboard marine engines was discussed in *Lubrication* [135].

Requirements of the lubricant and an explanation of the mechanism of lubrication in 2-stroke small engines were given by Towle [136]. Spark-plug whiskering, port blocking, piston deposits, and ring sticking were investigated in bench and road tests with different engines and oils. Cylinder wear in road tests using an SAE 10W lubricant was double that with an SAE 30 lubricant, but showed only a small reduction when changing from an SAE 30 to an SAE 50 oil.

In a later paper, Towle [137] reviewed major problems of lubrication of 2-stroke small engines, discussed effects of oil-base stock and additives, gave reasons for adoption of the 2-stroke cycle, and indicated the basic formulation of a suitable lubricant.

Ellis [138] presented an extensive review of the lubrication problems and theory of lubrication of 2-stroke small engines. Corresponding differences with 4-stroke engines were noted. The operational factor of efficient oil and fuel blending before use in the engine was emphasized. Initial failure of conventionally formulated oils led to the widespread rejection of the use of additives, but recent research and published work have modified this opinion. Base oils and additives were discussed, and the components of an ideal oil were indicated.

The performance and choice of lubricants and fuels used in tracked vehicles and motored power sets of equipment for a British Trans-Antarctic expedition were discussed by Pratt, Christie, Coxon, and Lodwick [139]. Lubricants were required to operate in temperatures of −79 F.

In another paper Pratt [140] gave more details of the vehicle performance during the Trans-Antarctic expedition. Bearing starting temperatures were as low as −60 F, while running temperatures were as high as 200 F. Engines tended to overheat rather than run cold at 1 to 8-mph speeds.

Manufacturers' recommendations on automotive lubricants for European cars were given in *Lubrication* [141].

Bozzelli [142] presented design aspects of an automatic-transmission fluid and indicated that this is one of the most detailed and precise products made by a petroleum refiner. Properties of the fluid require compatibility with other commercial fluids, and minimums in viscosity index, viscosity, flash point, fire point, antifoaming, anticorrosiveness, antirusting, effect on seal compound, oxidation, varnish, sludge, and nontoxicity. Shift smoothness was discussed as an important property associated with oxidation stability.

Similar information on automatic-transmission fluid was given in *Scientific Lubrication* [143].

Haviland and Rodgers [144] found that frictional quantities of automatic-transmission fluids affected shift performance. Their studies in full-scale transmissions and bench tests revealed an interrelationship between fluid oxidation resistance and slip-stick of the transmission clutch. Operation in an inert atmosphere essentially eliminated oxidation, but accelerated occurrence of stick-slip and squawk.

Hundre [145] reviewed the work of other investigators on the problems of gear lubrication and noted that by 1937 it was recognized that the lubricant was as important as the gear steel. Scoring, scuffing, and pitting damage were discussed; and the importance of the lubricant was emphasized.

The developments in the testing, properties, and specifications of automotive axle gear lubricants over a 30-year period were reviewed by Cunningham and Dinsmore [146].

Elliott, Hitchcock, and Edwards [147] presented the development of hypoid-gear oils and methods used for their evaluation in Great Britain and the U.S. Original EP additives functioned satisfactorily at high speed and load but not at low speed and high torque. This problem was overcome by use of composite additives. Lubricant evaluation originally was on full-scale axle tests, but now evidence points to the permissible use of small laboratory EP machines. Test procedures were summarized and oil properties tabulated.

Bus and truck-engine oil requirements and performance and a discussion of transmission, rear axle, and chassis lubricants and lubrication were given in *Lubrication* [148].

Clark, Harvie, and Nash [149] described progress in the development of a transaxle lubricant. Requirements of oxidation stability, additive life, antifoaming, and wear resistance for axles have been met, as well as volatility, lubricity, and antifoaming for the transmission; but other problems remain, such as scoring resistance, seal life, and availability.

Nelson and Valentine [150] compared truck-axle and transmission lubricant requirements on load-carrying capacity, operating temperature, rolling and sliding velocities, and lubricating properties in consideration of the possible use of a common lubricant for transmission and rear axle.

Calish [151] reported that a common transmission and axle lubricant formulated with a base-oil-additive combination, selected on the basis of extensive laboratory and

field tests, has been used successfully in some heavy-duty vehicles since 1947. Field experience covers operation in seven western states.

Laboratory tests on hypoid-gear lubricants SAE 90, multipurpose gear lubricants MIL-L-2105, and heavy-duty engine oils SAE 50 by Fletcher [152] indicated that if the transmission lubricant be eliminated, then an effort should be made to develop a common engine-transmission lubricant instead of a transmission-rear-axle fluid.

Johnson [153] concluded from laboratory and field tests that lubrication of the engine, transmission, and rear axle with different lubricants having appropriate viscosity and load-carrying characteristics would be more economical than design changes to permit the use of multipurpose lubricants.

Raymond [154] discussed the need for co-operation in research by the petroleum and automotive industries on current and future problems of lubricant requirements relating to high compression ratios, automatic transmissions, and new axles.

Later, Raymond [155] discussed major problems in development of a transaxle lubricant.

Daley [156] discussed the development of hypoid-gear lubricants corresponding to the development of the gears and indicated the need for a lubricant to withstand higher loads than present ones.

Bridgeman [157] discussed GL-4 type gear lubricants with reference to lubrication of limited-slip differentials, transmissions, and gears. The implication of GL-4 definition, responsibilities of the lubricant manufacturer, and mechanical limits of gears were noted.

Noll [158] explained the API service HL-4 designation, responsibility of the lubricant manufacturer, and reasons for developing the designation. Service deterioration of the lubricant and a gear-lube drain period were discussed.

Deposits and Sludge. The reactions and conditions favorable to the formation of sludge in lubricating oil and its consequential detrimental effects were described by Brewer [159]. Recommendations to control sludge were periodic inspection of used oil and careful selection of new oil.

Problems in deposit formation in engines caused by coking of the lubricants were discussed in *Petroleum* [160]. Volatility, oxidation stability, thermal stability, surface temperature, surface catalytic effect, oxygen content of surrounding atmosphere, and contact time were given as oil and environment variables which affect deposits.

Rouze and Forster [161] studied engine cleanliness in relation to the detergency level of the lubricant in road tests and determined that sludge and varnish formation tended to increase with mileage, but satisfactory engine cleanliness could be achieved when the oil-drain interval was based upon electron-microscope examination of the used oil. A supplement to additive conventional detergent oil showed high resistance to rust, varnish, and sludge formation.

Golothan [162] investigated the influence of base oil and additives on formation of deposits and spark-plug fouling in 2-stroke small engines. His results showed that the base oil had little effect on plug fouling, piston and crankcase deposits, and ring sticking; but port deposits increased with higher viscosity oil. Some metallic additives reduced port deposits but increased spark-plug fouling.

Lowther, Shea, and Kresge [163] studied piston cleanliness, exhaust-system deposits, spark-plug fouling, and wear in 2-cycle small engines as influenced by the oil base stock and additives. Their findings showed that the detergent was a predominant factor in piston cleanliness. Detergent and base stock affected port deposits, but base stock had little effect on spark-plug fouling.

Madden and Tuuri [164] identified contaminants in used oil and interpreted results. They indicate that an excessive amount of contaminant inferred depletion of additives or some impending mechanical problem. Source of contaminants, their damage and analysis, were summarized.

Analytical techniques for separating and identifying components of engine deposits were described [165].

Spilman and Ford [166] showed that sludge and contaminants (as measured in routine analytical tests), in used oil from laboratory and field tests with taxicabs and small delivery trucks, correlated with engine performance and indicated how and why deposits were formed.

Von Fuchs [167] evaluated the resistance of lubricants to oxidation and sludge formation under dynamic-equilibrium conditions by means of a bomb oxidation test. The method can determine mutual compatibility of new and used oils and remaining life expectancy of oils in service.

Rogers and Jonach [168] studied the mechanism of deposits on the underside of intake-valves and discussed the influence of the lubricant, fuel, engine design, and operating condition.

Composition and Additives. Loeser, Wiquist, and Twiss [169] studied the mechanism of sulfur in an EP film on an automotive cam and tappet run in a motor oil containing radioactive S_{35} synthesized into zinc dialkyl dithiophosphate. Phosphate-coated surfaces increased the bound sulfur in the EP film. Zinc and phosphorus in the EP film increased more rapidly than sulfur with increased temperature and/or pressure.

In another paper, Wiquist, Twiss, and Loeser [170] investigated distribution of an EP film on wear surfaces and determined the areas of EP-film concentration on the mating parts of an engine valve train, using radiotracer counting, autoradiographic analysis, densitometer tracings, and numerical integration.

Reynolds [171] discussed basic extreme-pressure elements and combinations of elements, their general surface activity, and suitable applications.

A series of long-chain phosphates and phosphonates was examined for suitability as lubricity agents in a joint study by Messina, Peale, Ackerman, Sasin, and Swern [172]. The EP, antiwear, antioxidant, and rust-preventative qualities also were investigated. They found that the long-chain-phosphorus compounds compared favorably with commercial products and that some were multifunctioning. The most promising lubricity agents, effective antiwear agents, and extreme-pressure agents were indicated.

Byrne [173] investigated the use of long-chain polymers to improve the VI of lubricating oils and discussed a theory of viscosity representative of the behavior of long-chain polymers within the lattice structure of a

fluid. The effectiveness of a VI improver in an automotive lubricant becomes reduced because of shear susceptibility which results in viscosity breakdown.

Arend [174] pointed out that all inhibitors do not have the same response in different oils and that an additive may improve one property of a lubricant but adversely affect another. The main functions of inhibitors and additives for lubricating oils, the requirement of additives for those purposes, and the importance of selecting the correct additive were discussed.

Vineall and Taylor [175] reported that the presence of molybdenum disulfide in motor oil did not give rise to deposits and that they found no evidence that it deteriorated to promote wear; rather wear was prevented. In engine tests running from 35,000 to 39,000 miles, wear was less than expected.

Curphur [176] discussed additives development and the mechanism of their functions in automotive lubricants. Importance of molecular structure was emphasized. Some polymeric substances, such as alkylated polystyrenes, act as VI improvers in naphthenic oils because of the aromatic nuclei in their structure; the length of the alkyl chain, however, increases the compatibility of the polymer with the more paraffinic oils.

Larson [177] indicated the extent of the use of zinc dialkyl dithiophosphates in motor oils in the U.S., and discussed the mechanisms of the functions: oil antioxidant, bearing anticorrosion, and wear reduction of cams and lifters with test detail and data.

Kadmer [178] discussed composition, properties, and limitations of the lubricant additives: pour-point depressants, VI improvers, corrosion and wear inhibitors, detergent-depressants, and EP agents.

Oakes [179] evaluated extreme-pressure additives and discussed the mechanism of their action. Load capacity of uncatalyzed reaction products in sulfurized oils was determined to be higher than that of catalyzed. Disulfide linkages had lower EP than polysulfides. The load-carrying capacity of both sulfurized and chlorinated oils appeared to be a function of olefin type rather than of sulfur or chlorine content.

Ingold and Puddington [180] discussed the mechanisms of antioxidants in oils. They indicated that the efficiency of amine antioxidants in oils may be greater than measured due to removal of amine from the oil by reaction with acidic hydroperoxide products. Synergistic effects between amine inhibitors, some soluble bases, and other compounds suggest ways for increasing inhibitor efficiencies.

Sprag and Cunningham [181] pointed out that special antifriction lubricants were needed for noise-free operation of a mechanism containing wet clutches such as an automatic transmission. Authors used a modified 4-ball tester to investigate parameters of transmission fluids. Their results showed effects of additive type, concentration and interaction of additives, lubricant degradation, and clutch-face materials.

Savin [182] used laboratory engine tests to study those factors of base-stock composition and various additive classes, alone or in combination, which affect lubricant performance in 2-cycle small engines. He pointed out that all components of the oil must be compatible with each other and the fuel under combustion conditions, and concluded that additive oils carefully compounded to engine requirements performed better with respect to deposits, wear, and spark-plug operation than the best nonadditive oil.

Investigation of lubricants for 2-stroke small engines by Bowman and Burchell [183] revealed that lubricants containing ashless detergents at 3 to 5 per cent concentration performed satisfactorily over a wide range of speed, load, and temperatures. Uncompounded oils caused piston and ring belt deposits, port clogging, ring sticking, and loss in engine performance. Metallic detergent additives controlled deposits but tended to promote spark-plug fouling.

The value of additives in increasing engine cleanliness and reducing wear was verified by engine tests, using SAE 20 and SAE 10W/30 straight mineral oils and additive-containing oils to Supplement I level of performance, and reported by *Automobile Engineer* [184].

Hunstad, Wilkins, Osborne, and Davison, Jr. [185] made additive-evaluation studies and described research on development of a transaxle lubricant. From a number of EP additives tested separately, only three showed sufficient promise to warrant testing in a transaxle lubricant. One, di(n-dedecyl) phosphate, provided a link between chemical composition and mechanical performance. Compatibility with clutch-plate materials improved with the carbon-chain length. Five promising transaxle fluids were screened from plumbed car, bench, and proving-ground tests on 32 mineral-oil-base fluids, 10 synthetic-base fluids, and numerous base-stock-additive combination fluids.

Randall, Andrus, Fein, and Kluge [186] studied the additive mechanism involved in low-temperature wear of cylinder and piston rings. They indicated that fuel combustion-product acids were the principal cause of wear. Additives that adsorb on the surface and prevent intermetallic contact do not necessarily form a close-packed film to prevent acid corrosion of the surface. They pointed out that effective surface protection and alkalinity must be built into the oil, since these effects function simultaneously.

Kaplan and Sesekin [187] examined the influence of ferric naphthenate on the thermal breakdown of polymers in thickened oils in the presence of oxygen and air. They found that ferric naphthenate in all cases contributed to the polymer breakdown and that a free-radical mechanism was involved at temperatures of 50 and 100 C.

Klimov and Zarudnii [188] studied breakdown of polyisobutane in mineral oil and reported that the polymer bonds break above a critical value of molecular weight of the polymer for a given shear stress. The extent of the breakdown depended upon the magnitude of the shear.

Information on additives in motor lubricants, mostly descriptive but of value to those engaged in work on additives for motor oils, was given in *Petroleum Refiner* [189].

Multigrade Lubricants. Musselman and Darling [190] discussed the influence of polymers on oil properties of multigrade lubricants for automotive engines. Low-temperature viscosity affects start-up lubrication, high-temperature viscosity relates to low oil consumption, and high-shear viscosity relates to engine friction. The favorable influence of polymers on viscosity justifies multigrade engine lubricants.

Developments in Bearings and Lubricants

Grindrod [191] gave a résumé of U.S. tests and research by Standard Oil of Indiana, covering field tests in heavy-duty service with multigrade lubricants, which revealed that engine wear and oil consumption were equal to or better than for single-grade oils in similar service. Also, fuel economy and easier cold-weather starting outweighed their additional cost.

La Croix and Kalinowski [192] made laboratory engine tests on seven commercial 10W/30 oils and found that octane-requirement increase was affected more by motor-oil composition differences as the engine compression ratio was increased. Surface ignition, rumble, and spark-plug fouling were alleviated by additives containing phosphorus.

Brenneman and Nostrand [193] reported that the ability of multigrade 10W/30 motor oils to control engine cleanliness was markedly improved by the use of a dispersant-type VI improver in combination with detergent inhibitors. The effectiveness of the VI-improver dispersants was tested in stop-and-go taxicab service.

Wear. Physical and chemical methods of wear measurement and their limitations applied to wear on engine components were reviewed and compared with radiotracer methods in *Scientific Lubrication* [194]. Sensitivity of radiotracer methods was emphasized, but its limitation of the inevitable loss of some of the wear particles was noted. Radiotracer equipment and test procedures used by several investigators were described, and their test results were briefly discussed.

Thiery [195] reported on piston-ring wear, friction, and corrosion, both at start and steady-running conditions in a Petter AVI test engine, determined by the IFP-RA3 radiotracer method using four different oils. The start-up wear was influenced by the cylinder temperature during down time and length of down-time period, oil viscosity, sulfur content of fuel, and anti-corrosion additives.

In another paper, Thiery [196] gave details and explained the principles of the IFP-RA3 radiotracer method of engine-wear determination, discussed applicability to Petter diesel and automotive gasoline engines, and considered factors relating to: friction start-up wear, friction steady-running wear, corrosive start-up wear, and corrosive steady-running wear.

Test results accumulated from the use of Institut Français du Pétrole's IFP-RA3 radiotracer method and noted in *Petroleum Week* [197] showed that engine-start-up wear was reduced by oiliness agents, VI improvers, and any operational factor which contributed to better adhesion of the oil film on the cylinder wall.

Robbins, Pinotti, and Jones [198] studied ring wear in a medium-speed diesel engine by means of radioactive technique and showed that changes in speed, load, and jacket water temperature between 140 and 200 F in combination with distillate fuel did not affect wear rate of cast-iron rings. But with residual fuel, wear of cast-iron rings increased with a decrease in speed and jacket water temperature below 16 F. Residual fuel did not influence wear of chrome rings with decrease in load.

Furey and Kunc [199] described techniques using radioisotopes to study metal transfer, nature of wear fragment, and nature of surface film for investigation of wear and lubrication of parts of an internal-combustion engine.

Halliwell [200] investigated the effects of the level of oil detergency, abrasive particle size, and the use of filters on wear in a marine diesel by means of a radioactive-isotope tracer technique and found that detergent oils used in a relatively clean engine would minimize piston-ring wear to a lower relative value as the detergency level was increased. Filters were recommended.

Abowd, Jr. [201] investigated causes of piston-ring wear occurring during abnormal combustion by means of a radioactive-tracer technique in laboratory and field tests. Continuous preignition caused high adhesive wear on the top piston ring, but engine knock had no effect. Adhesive wear of the top chrome ring with two dispersant alkaline-barium-type oil additives showed that the chrome wear decreased with increasing barium concentration, and was less with the phenol sulfide than with the sulfonate at all concentrations.

Arnold, Stonehocker, Braun, and Sunderman [202] jointly investigated wear in the liner and piston rings of a large diesel engine by means of a radioactive-tracer method. The 160-lb liner was irradiated selectively over a $1^1/_2$-in. band width at the inner-dead-center area of the compression-ring travel. Wear data were obtained on the liner with engine operated on distillate, residual, and variable fuels. Irradiation techniques and shielding methods were described.

Similar information on engine wear, with the use of a radioactive liner in a Caterpillar diesel engine and the safety precautions, were given in *Diesel Power* [203]. Liner wear increased rapidly with increasing load and with water-jacket temperature below 150 F.

Wiquist [204] reviewed the use of radioisotopes for studying surface phenomena covering engine wear and action of additives by means of a radioactive-tagged component in the lubricant or fuel, an activated part, reaction with a suitable radioactive material for detection of elements having no radioisotopes, and activating and identifying wear particles collected from a nonradioactive test.

Pietschmann [205] described the simultaneous determination of wear on four components of an internal-combustion engine by means of emission spectroscopy. Various other methods for determination of wear in engines were evaluated and compared, particularly the radioactive method.

Dawtrey [206] reported that cylinder wear leading to high oil consumption was due to lack of lubrication during the first few minutes of start-up, particularly at cold temperatures. A top compression chrome ring aids in control of wear and oil consumption. Several aids to assist cold starting were indicated.

Loeser [207] reported on wear of cast-iron cam and tappets lubricated with five CRC oils in bench, dynamometer, and field-car tests. The amount of wear measured differed among the three sources. Influence of some additives on wear of the cam and tappets was investigated. A preference was indicated for the bench-test method for wear determination.

Gow [208] reported findings of low-temperature tests of corrosive wear with MS oils. Most of the MS oils gave similar protection against wear while fresh, but varied in effectiveness as mileage was accumulated. Comparison of data from field service with those of new oils showed that corrosive wear rate increased 25 per cent

after 500 miles of use, slightly more than doubled after 1000 miles, and was five times as great after 2500 miles.

Robinson, Thomson, and Webbere [209] investigated surface films on tappets in a bench-test apparatus and reported that the formation of a surface antiwear film on the contact surfaces in relation to wear and scuffing was more a function of material than of the type of lubricant.

A method for measurement of wear on machine parts, such as cylinder walls, rings, and similar parts, was described by Kruschov [210]. Wear of parts was measured by the change in the outline dimensions of very shallow geometrical grooves cut in the part under observation.

Lees [211] described efforts to analyze statistically problems connected with wear in marine diesel engines by means of a punched-card system and a digital computer. Essential data were reported by 33 ships following 3000-hr inspection periods.

Oil and Engine Tests. Geissler [212] gave statistical methods used in analysis of lubricant tests to determine repeatability and reproducibility of tests.

Vanderbilt, Jr., and Zimmer [213] described a programmed test to determine service oil economy on engine wear. The block diagrams of the tape-recording systems, the servo, and the electronic systems were given.

Frassa and Small [214] described instrumentation for programming a test cycle and recording engine performance on a chassis dynamometer by means of magnetic tape, strip-chart recorder, and other associated instruments. The particular tests given were on fuel, but tests on lubricants are possible with this instrumentation.

Sproule, Lonstrup, and Pattenden [215] discussed methods and equipment used in field evaluation of crankcase oils and greases. Authors compared laboratory FL-2 tests with caravan fleet tests and emphasized the importance of correlating laboratory procedures with field results before rating oil quality.

Williams and Obberight [216] studied liquid-phase oxidation of lubricating oils at high temperature under highly oxidative conditions. Their data gave decreasing oxidation stability in the order of residual oils, distillate oils, and white oils. Authors studied catalytic action of aluminum, iron, and copper at 500 F. In their test apparatus, preheated oil was passed over a 12-in-diam revolving disk, with oxidation indicated by the rate of make-up oxygen supplied in a closed system.

Foehr and Calish [217] showed agreement of bench oxidation tests on transmission fluid with performance in transmissions. A modified Allison Type-C oxidation test, run at 350 F instead of 300 F and including steel and copper catalyst wires, was reported to predict stability of an automatic-transmission fluid and provide means of observing depositions of sludge and lacquer.

Dean and Stendahl [218] developed a low-cost bench test for oxidation stability of automatic-transmission fluids and found agreement with the Powerglide L-39 transmission test. Rubber-swell properties were considered and a mileage-accumulation dynamometer was used to study shear stability, results of which correlated with the 50-hr hydromatic durability test. They indicated that make of transmission and type of VI improver affected results.

Kite and Koenig [219] reviewed requirements of automatic-transmission fluids Type A and discussed tests to determine performance, such as Type-A oxidation tests, motored transmission oxidation tests, durability cycling test, squawk tests, and so forth.

Similar information was given in *Lubrication* [220].

Selby [221] investigated the low-temperature performance of automatic transmissions and found that most failures occurred between temperatures of −10 to −15 F, with a few as low as −25 F. Viscosity at failure was 4900 ± 1200 centipoises by test and 5300 centipoises by calculation. Clutch-plate condition was the criterion of failure, and clutch-plate burns increased as the temperature was decreased below the failure temperature.

Crosthwait and Greenawalt [222] used Brookfield viscosities at low temperature to study fluid performance of automatic-transmission fluids under extreme-cold conditions. Lighter-viscosity base oils offered the best low-temperature fluidity, equivalent automatic-transmission-fluid viscosity characteristics could be obtained with different mineral-base oils, and the VI improver was a major factor in controlling low-temperature viscosity while detergents, antioxidants, and antisquawk agents gave only a minor effect.

Brunner and Ruf [223] reported on the effects of lubricants on the starting and operation of gasoline and diesel engines at low temperatures. Cranking tests were conducted to determine limiting oil viscosities for operation at +14 to −22 F.

Volarovich [224] investigated oil and engine friction at low temperature (to −60 F) and found that the piston required a high force to shear the oil on the first stroke, after which the oil behaved in agreement with hydrodynamic theory. The oils tested at low temperature exhibited a static yield value and decreasing viscosity with increasing shear rate. Author recommended that lubricant viscosity should not exceed 100 poises at the starting temperature.

De Faro Barros and Dyson [225] presented a study of piston-ring friction when lubricated with low-viscosity oils. Ring friction traces showed hydrodynamic lubrication at mid-stroke and breakdown of hydrodynamic lubrication at ends of piston stroke. Forces were analyzed and discussed. Effects of ring loading, piston speed, oil viscosity, and composition were investigated.

Bowman and Savage [226] discussed laboratory methods for predicting performance of lubricating oils in silver-steel bearing combinations such as used in diesel engines. Wear and friction showed correlation between silver-strip corrosion test, Kinetic Oiliness Machine test, and silver-plated wrist-pin bearing of one diesel engine. Authors found that oils having low silver-steel friction had low silver corrosion tendencies, but the reverse was not necessarily true.

Belt and Schneider [227] reported on the U. S. Navy's lubricant-development programs which consider piston-pin wiping, exhaust post deposits in submarine diesels, and development of a single specification for all Navy diesel-engine lubricants. Reported correlation between Kinetic Oiliness Machine results and wrist-pin bushing in engine tests will be examined.

Bryan, Neerman, and Hinsch [228] determined the amount of lubricant in an engine's exhaust gases. Their method employed an alkali tracer element in the lubricant which was detected quantitatively in the ex-

haust with a flame photometer. Method provides a means of testing short-term oil consumption.

Pobereskin, Sunderman, and Fithian [229] reported on the influence of operating conditions upon oil consumption in a diesel engine having a radioactive tracer in the lubricant. Oil consumption correlated with wear.

Starkman [230] investigated oil consumption and routes of oil loss in a CFR 1-cyl test engine. Tritium tagging of the lubricant and scintillation counting of the exhaust and breather vapors showed that the lubricant left the engine only partially burnt. Effects of spark setting, cooling-water temperature, and different fuels were indicated.

Matveevsky [231] studied the influence of temperature on lubricating capacity of mineral oils. His tests on a 4-ball machine, modified to permit heating or cooling of the test oil, showed an upper temperature limit for each nonadditive oil at which friction increased rapidly.

Hirano and Yamamoto [232] investigated effects of hardness and concentration of particles in lubricating oil by means of 4-ball tests. Viscosity of the oil and rubbing speed were considered. An empirical expression was given relating the concentration of particles to the area of abrasion. The areas of impression increased with an increase in oil viscosity and particle hardness.

Augustin [233] investigated friction and lubrication in a single-cylinder 2-cycle engine with oils containing colloidal graphite. Photomicrographs of cylinder liners after 400 hr of heavy-duty operation showed homogeneous layers of graphite platelets, but similar liners without graphite in the oil showed scoring and rust.

Meckel and Quillian [234] studied gear-lubricant thermal-oxidation degradation and discussed results. Authors described apparatus and test method of the study which was developed to evaluate EP gear lubricants for the new tentative Military Specification M-L-2105A and includes high torque, high-speed shock, and moisture corrosion tests in addition to oxidation-stability test.

Ryder [235] discussed testing and rating of the antiscuff and load-carrying properties of lubricants by the Ryder Gear Rig and compared features of the test rig with those of the IAE, Thorton, FZG, Shell Development, and Western Gear Test Machines.

De Ardo and Sargent, Jr. [236] combined test data from the Falix, Timken, and 4-ball machines to devise an inexpensive short method for evaluation of load-carrying capacity of gear lubricants under boundary conditions.

Smith [237] outlined a test program used at WADC for evaluating gear lubricants using a Ryder gear tester. This evaluation determines the effect of viscosity, shear characteristics, and film thickness of the lubricant. Also, temperature and pressure effects upon the stress corrosion, scuff load, and gear fatigue.

Brandow [238] discussed test results on three MIL-L-2105 and one MIL-L-2105A EP gear lubricants in the rear axles of 25 trucks of one manufacturer, operated by a commercial carrier in an over-the-road fleet. Results gave effect of lubricant on formation of deposits, rust or corrosion, bulk oil temperature under normal service, and over-all axle life.

Sands [239] pointed out shortcomings of gear-lubricant specification MIL-L-2105 and noted the added requirements of specification MIL-L-2105A.

Johnson [240] gave examples of erratic performance of multipurpose MIL-L-2105 type lubricants, and special fatigue tests on a transit-coach axle indicated longer life with GL-4 or MIL-L-2105A gear lubricant.

Analysis. Gibb and Gibson [241] discussed the analysis of acidity in lubricating oils. They reviewed difficulties encountered with current test methods and dark oil samples and recommended a method of marked fluorescent indicator in preference to the current ASTM D-974 and D-664, 13-S-283 4, and 1P-139 methods.

Barger, Bolze, Hughes, and Medved [242] described details of a semiadiabatic calorimeter and gave a rapid method for obtaining heat capacity of a liquid over a temperature range from ambient to 500 F in 6 hr with less than 5 per cent error.

Scientific Lubrication [243] described apparatus and a photometric method (developed by the French Institute of Petroleum) for determination of carbonaceous matter in used diesel-engine oils, which will enable an unskilled operator to make an analysis in the field. Only two drops of sample oil are required.

Barney, Bergmann, and Tuskan [244] reported on a rapid analysis of phosphorus in motor oils and additives. Precision equal to that of ASTM D-1091-54T was reported. Analysis may be completed in 1 hr with phosphorus determined either colorimetrically, as in the ASTM method, or by differential spectrophotometry.

Schilling and Marlot [245] in a French bulletin gave a description of the IFP spot-test procedure and of two commercial testing kits.

Porter and Johnson [246] described a gas-chromatography column method for determination of fuel dilution in lubricating oils. Although results were higher than ASTM distillation procedure, a $^1/_4$-ml volume of sample was sufficient.

Elsey [247] reported on a chromatographic rapid determination of dissolved oxygen in lubricating oil. The analysis required about 10 min, with argon the only known interference.

Yao and Porsche [248] described apparatus and procedure for a 5-min analysis by x-ray fluorescence for sulfur and chlorine in petroleum fractions and lube-oil additives.

Winston [249] reported that the use of a photospectrometer to detect metallic particles in engine-crankcase oils by the Pacific Intermountain Express has resulted in considerable dollar yearly savings in oil, filters, and maintenance.

Hensley and Barney [250] presented a titration-test method for rapidly determining barium, calcium, and zinc in lubricating oil and additives which may be completed in 1 hr with better accuracy claimed than that of ASTM-D811-48.

Bernelin [251] made an electrochemical study of the micellar state of detergents in lubricating oils and demonstrated experimentally that the detergents exist as ionic colloids in hydrocarbon solution.

Miscellaneous. Two [252] proposed rerefining of used lubricating oil as a conservation of crude oil.

Atchison and McBrian [253] reviewed the functions of lubricating oil in heat engines, which are: lubrication of moving parts, cooling, heat transfer, and transport of fuel wastes and contaminants to the filter.

Echols and Cordera [254] described a 12-engine test

facility and operating procedure for evaluation of lubricants and fuels under controlled conditions.

Lewis, Risher, and Wilson [255] described an 8-lane automatic road dynamometer test facility for evaluation of lubricants and fuels.

Engine-oil drain period was discussed by several authors: Jennings [256] gave a cost-analysis relative to labor, oil, and length of drain period with regard to truck fleet operation. Lane [257] reported cost differences between 1000 and 3000-mile drain period for passenger cars and recommended a 1000-mile drain period. Sibley [258] considered a 6000-mile drain period satisfactory for passenger cars under normal operation and 2500-mile period under severe operation. Glynn [259] considered both time and mileage factors and summarized data of manufacturers' recommendations for years 1939, 1949, and 1959. The four papers [256–259] were summarized in the *SAE Journal* [260]. Bardy [261] reported that with oil-drain periods less than 1500 miles in cab-fleet service, the varnish, sludge, rust, and wear were reduced considerably. Cubiciotti [262] gave results of surveys on oil-drain period which indicated that 42 per cent of those questioned adhered to an oil-drain period of less than 2000 miles.

The API recommendation to the typical motorist to drain oil every 30 days in winter and every 60 days in summer, but never to exceed 2000 miles was discussed by Moore [263].

Engine-oil drain period was reported in *Petroleum Week* [264].

References

Friction and Wear

1 "Hydrodynamic Lubrication: Boundary Friction and Boundary Lubrication," Institution of Mechanical Engineers, Proceedings of Conference on Lubrication and Wear, London, England, October 1–3, 1957.

2 F. P. Bowden, "A Review of the Friction of Solids," *Wear*, vol. 1, no. 4, 1958, p. 333.

3 F. T. Barwell, "Wear of Metals," *Wear*, vol. 1, no. 5, 1958, p. 418.

4 A. W. Crook, "Some Studies of Wear and Lubrication," *Wear*, vol. 2, no. 5, 1959.

5 F. P. Bowden, "Some Recent Experiments on Friction, Wear and Deformation of Solids," SAE Paper-n-17R, January, 1959, p. 7.

6 J. F. Archard, "Temperature of Rubbing Surfaces," *Wear*, vol. 2, October, 1959, pp. 438–455.

7 D. Tabor, "Junction Growth in Metallic Friction: The Role of Combined Stresses and Surface Contamination," Proceedings of the Royal Society (London), vol. 251, 1958, p. 378.

8 C. Rubenstein, "Coefficient of Friction of Metals," *Wear*, vol. 2, November, 1958, pp. 85–96.

9 I. V. Kraghelsky and N. B. Durkin, "Contact Area of Rough Surfaces," *Wear*, vol. 3.

10 E. Rabinowitz, Conference on Lubrication and Wear, October, 1957, Inst. Mech. Engs., ASLE-ASME Lubrication Conference, Toronto, Ont., Canada, October, 1957.

11 A. Iwaki and M. Mori, "Distribution of Surface Roughness When Two Surfaces Are Pressed Together," *Bulletin of the Japan Society of Mech. Engrs.*, vol. 1, November, 1958, pp. 329–337.

12 F. F. Ling and R. C. Lucek, "On Model Studies of Metallic Surface Asperities," *Journal of Applied Physics*, vol. 30, 1959, pp. 1559–1563.

13 O. L. Anderson, "Laws of Adhesion," *Journal of Applied Physics*, vol. 30, 1959.

14 W. P. Manson, "Adhesion Between Metals and Its Effect on Fixed and Sliding Contacts," *Trans. ASLE*, vol. 2, no. 1, 1959.

15 L. F. Coffin, Jr., "Fundamental Study of Synthetic Sapphire as Bearing Material," *Trans. ASLE*, vol. 1, April, 1958, pp. 108–114.

16 P. Benjamin and C. Weaver, "Measurement of the Adhesion of Thin Films," *Proceedings of the Royal Society* (London), *A*, vol. 9, February, 1960, p. 163.

17 P. Benjamin and C. Weaver, "Condensation Energies for Metals on Glass and Other Substrates," *Proceedings of the Royal Society (London) A*, vol. 252, September, 1959.

18 A. M. Bueche and D. G. Flom, "Surface Friction and Dynamic Mechanical Properties of Polymers," *Wear*, vol. 2, February, 1959, pp. 168–182.

19 M. B. Peterson, J. J. Florek, and R. E. Lee, "Sliding Characteristics of Metals at High Temperatures," ASLE Paper No. 59LC-5.

20 D. H. Buckley and R. L. Johnson, "Influence of Silica Additions on Friction and Wear of Nickel Alloys at Temperatures to 1000 F," ASLE Paper No. 59LC-11.

21 K. P. Zeeman and L. F. Coffin, "Friction and Wear of Refractory Compounds," ASLE Paper No. 60AM6C1.

22 E. P. Kingsbury and E. Rabinowitz, "Friction and Wear of Metals to 1000 C," *Trans. ASME—Journal of Basic Engineering*, Ser. D vol. 81, 1959, pp. 118–122.

23 D. E. Miller, "Measurement of Dry Sliding Friction at Elevated Temperatures," ASME Paper No. 58—A-225.

24 G. W. Rowe, "Molybdenum Disilicide for High Temperature Sliding," *Engineering*, vol. 206, September 26, 1958, p. 487.

25 J. P. Denny, "Analysis of Bearing Materials for Elevated-Temperature Application," "APEX-464," General Electric, Atomic Products Division, Aircraft Nuclear Propulsion Department, Cincinnati, Ohio; February, 1959, 38 pp.

26 G. P. Allen, D. H. Buckley, and R. L. Johnson, "Friction and Wear With Reactive Gases at Temperatures up to 1200 F," NACA Tech. Note 4316, September, 1958, 26 pp.

27 Donald H. Buckley and R. L. Johnson, "Halogen-Containing Gases as Boundary Lubricants for Corrosion-Resistant Alloys at 1200 F," NASA Memorandum 2-25-59 E, March, 1959.

28 G. W. Rowe, "Coatings on Molybdenum for High Temperature Sliding," *Scientific Lubrication (London)*, vol. 11, October, 1959, pp. 12–15.

29 F. C. Wagner and J. T. Burwell, Jr., "New Retainer Materials for Aircraft Gas-Turbine Bearings," *Trans. ASLE*, vol. 1, April, 1958.

30 R. H. Baskey, "A Research Program on the Investigations of Seal Materials for High-Temperature Applications," ASLE Paper No. 59LC-8.

31 D. W. Wisander, W. F. Hady, and R. L. Johnson, "Friction Studies of Various Materials in Liquid Nitrogen," NACA Tech. Note 4211, February, 1958, 35 pp.

32 F. P. Bowden and H. G. Scott, "The Polishing, Surface Flow, and Wear of Diamond and Glass," *Proceedings of the Royal Society (London) A*, vol. 248, 1958, p. 368.

33 F. P. Bowden and E. H. Freitag, "The Friction of Solids at Very High Speeds," *Proceedings of the Royal Society (London) A*, vol. 248, 1958, p. 350.

34 M. Cocks, "Role of Atmospheric Oxidation in High-Speed Sliding Phenomena, II," *Trans. ASLE*, vol. 1, April, 1958, pp. 101–107.

35 A. S. Vagramyan, "New Method of Measuring Temperature of Sliding Friction Between Dissimilar Metals," *Engineers Digest*, vol. 19, October, 1958, p. 440.

36 H. D. Friedman and P. Levesque, "Reduction of Static Friction by Sonic Vibrations," *Journal of Applied Physics*, vol. 30, October, 1959, pp. 1572–1575.

37 K. V. Savitskii and M. P. Zagrebennikova, "Influence of Forced Slip of Faces in Plastic Compression of Metals," *Physics of Metals and Metallography* (translation of *Fizika Metallov i Metallovedenie*), vol. 5, no. 1, 1957, pp. 92–96.

38 N. H. Cook, "Study of Dynamic Friction," ASME Paper No. 58—A-257.

39 Y. Tamai, "Low Friction of Metals in Reciprocating Sliding," *Journal of Applied Physics*, vol. 30, December, 1959, pp. 1874–1875.

40 J. D. Huffington, "Theory of Friction of Polymers," *Research*, vol. 12, 1959, pp. 443–446.

41 J. D. Huffington and H. P. Stout, "The Friction of Fiber Assemblies," *Wear*, vol. 3, no. 1, January, 1960.

42 D. I. James, "Surface Damage Caused by Polyvinyl Chloride Sliding on Steel," *Wear*, vol. 2, February, 1959, pp. 183–194.

Developments in Bearings and Lubricants

43 L. Eisner, "Materials With Large Friction Coefficients," *American Journal of Physics*, vol. 27, January, 1959, p. 59.

44 D. F. Denny, "Time Effects in Static Friction of Lubricated Rubber," *Wear*, vol. 2, May, 1959, pp. 264–272.

45 R. A. Kozlik, "Wear and Frictional Characteristics of Some Nickel-Base Alloys," *Trans. ASLE* (Lubrication Science and Technology), vol. 1, 1958, pp. 296–303.

46 P. D. Miller and J. W. Holladay, "Friction and Wear Properties of Titanium," *Wear*, vol. 2, November, 1958, pp. 133–140.

47 T. Sata, "The Transient State of Wear by Repeated Rubbing," *Wear*, vol. 3, no. 2,

48 R. Steign, "Sliding Wear and Metal Transfer Under Unlubricated Conditions," *Trans. ASME—Journal of Basic Engineering*, Ser. D, vol. 81, March, 1959, p. 67.

49 R. Steign, "Investigation of Dry Adhesive Wear," *Trans. ASME—Journal of Basic Engineering*, Ser. D, vol. 81, 1959, p. 56–65.

50 M. M. Kruschov, "Determination of Wear of Machine Parts," *Wear*, vol. 3, January, 1960.

51 L. Germer, "The Erosion of Relay Contacts," *Wear*, vol. 3.

52 A. Schallanch, "Wear of Slipping Wheels," *Wear*, vol. 3, January, 1960.

53 J. Dearden, "Wear of Steel Rails and Tyres," *Wear*, vol. 3, January, 1960.

54 L. M. Neibylski, M. Antler, and L. O. Brockway, "Investigation of Wear by Electron Diffraction," *Trans. ASLE* (Lubrication Science and Technology), vol. 1, 1958, pp. 304–311.

55 V. D. Scott and H. Wilman, "Surface Reorientation Caused on Metals by Abrasion—Its Nature, Origin and Relation to Friction and Wear," *Proceedings of the Royal Society* (London), vol. 247, September 30, 1958, pp. 353–368.

56 J. M. Bailey and Allan T. Gwathmey, "Dislocation Arrays in Depth and Recrystallization Produced by Surface Deformation of a Single Crystal of Copper at High Temperatures," *Journal of Applied Physics*, vol. 31, 1960, p. 215.

57 J. Goddard, H. J. Harker, and H. Wilman, "Theory of Abrasion Solids Such as Metals," *Nature* (London), vol. 184, August 1, 1959, pp. 333–335.

58 P. K. Porgess and H. Wilman, "The Dependence of Friction on Surface Roughness," *Proceedings of the Royal Society* (London), vol. 252, August, 1959, p. 35.

59 M. Seal, "The Abrasion of Diamond," *Proceedings of the Royal Society* (London), *A*, vol. 248, 1959.

60 G. H. Robinson, R. F. Thomson, and F. J. Webbere, "Use of Bench Wear Tests in Materials Development," SAE Paper No. 17 S.

61 R. Weber, "Lagerwerkstoff-Prüfung," *Metall*, vol. 12, Feb. 1958, pp. 96–103; Aug. 1958, pp. 725–732.

62 G. I. Monastyrshin, "Matematicheskoe modelirovanie sukhogo treniya," *Avtomatika i Telemekhanika*, vol. 19, Dec. 1958, pp. 1091–1106.

63 H. Drescher, "Zur Mechanik der Reibung zwischen festen Körpern," *ZVDI*, vol. 101, June 11, 1959, pp. 697–707.

64 J. Thiery, "Application de la technique des radiotraceurs à l'étude de l'usure des segments de piston," Institut Francais du Pétrole et Annales des Combustibles Liquides—*Revue*, vol. 13, July–Aug. 1958, pp. 1197–1216.

65 A. Knappwost and E. Burkard, "Die Mischreibung als physikalisch-chemisches Festkörperproblem," *Z. für Metallkunde*, vol. 50, Sept. 1959, pp. 540–545.

66 K. Mueller, "Über den Einfluss der Oberflächengestalt und Oberflächenbehandlung," *Werkstatt u. Betrieb*, vol. 92, Jan. 1959, pp. 17–26; Mar. 1959, pp. 131–142.

67 G. Bellanger, "Le frottement et l'usure a sec, en relation avec les propriétés physiques et chimiques des couches superficielles et sous-jacentes," Institut Francais du Pétrole et Annales des Combustibles Liquides—*Revue*, vol. 13, Oct. 1958, pp. 1481–1484.

68 E. Fischer, "Über das Wesen der Reibung beim Übergang von der Ruhe in die Bewegung," Technische Hochschule—*Wissenschaftliche Z.*, vol. 7, 1957–1958, pp. 1023–1031.

Boundary Lubrication

69 "Special Conference on Lubrication and Wear Issue," *Scientific Publication* (London), December, 1957, pp. 43–161.

70 F. T. Barwell, "Report on Papers on Wear Presented at the Institution of Mechanical Engineers Conference," *Wear*, vol. 1, April, 1958, pp. 418–445.

71 C. W. Cowley, C. J. Ultee, and C. W. West, "Influence of Temperature on Boundary Lubrication," *Trans. ASLE*, vol. 1, 1958, pp. 281–286.

72 R. S. Fein, C. N. Rowe, K. L. Kreuz, "Transition Temperatures in Sliding Systems, *Trans. ASLE*, vol. 2, 1959, pp. 50–57.

73 E. Rabinowicz, "Theoretical Criteria for the Effectiveness of a Lubricant Film," *Trans. ASLE*, vol. 1, April, 1958, pp. 96–100.

74 A. Miller and A. A. Anderson, "Investigation of Oil Additives for Boundary Lubrication of Railroad Journal Bearings," *Trans. ASLE*, vol. 1, 1958, pp. 273–280.

75 Y. Tamai, "Interactions of Wear Debris With Fatty Additives in Lubrication," *Wear*, vol. 2, February, 1959, pp. 228–236.

76 F. Hirano and S. Yamamoto, "Four-Ball Test on Lubricating Oils Containing Solid Particles," *Wear*, vol. 2, August, 1959, p. 349.

77 F. W. Smith, "Lubricant Behavior in Concentrated Contact Systems—Castor-Oil Steel System," *Wear*, vol. 2, May, 1959, p. 250.

78 P. D. Miller and J. W. Holladay, "Friction and Wear Properties of Titanium," *Wear*, vol. 2, November, 1958, pp. 133–140.

79. A. M. Bueche and D. G. Flom, "Surface Friction and Dynamic Mechanical Properties of Polymers," *Wear*, vol. 2, February, 1959, pp. 168–182.

80 C. Rubenstein, "Coefficient of Friction of Metals," *Wear*, vol. 2, November, 1958, pp. 85–96.

81 A. Cameron, "A Theory of Boundary Lubrication," *Trans. ASLE*, vol. 2, May, 1960, pp. 195–198.

82 L. F. Coffin, Jr., "Boundary Lubrication, Wear-in and Hydrodynamic Behavior of Bearings for Liquid Metals and Other Fluids," *Trans. ASLE*, vol. 1, April, 1958, pp. 139–150.

83 P. A. Bennett, "Look at Effects of Lubricant Additives on Surfaces," SAE Paper No. 107B, 1958.

84 E. H. Loeser, R. C. Wiquist, and S. B. Twiss, "Cam and Tappet Lubrication—III: Radioactive Study of Phosphorous in EP Film," *Trans. ASLE*, vol. 1, 1958, pp. 329–335.

85 G. Hugel, "Chemical Nature of Extreme-Pressure Lubrication," *Lubrication Engineering*, vol. 14, December, 1958, pp. 523–526.

86 L. M. Niebylski, M. Antler, L. O. Brockway, "Investigation of Wear by Electron Diffraction," *Trans. ASLE*, vol. 1, 1958, pp. 304–311.

87 G. H. Robinson, R. F. Thomson, and F. J. Webbere, "Use of Bench Wear Tests in Materials Development," SAE Paper No. 17S, 1959.

88 H. S. White, "Laboratory Tests With Turboprop Lubricants," *Trans. ASLE*, vol. 1, April, 1958, pp. 51–67.

89 "Hydrocracker Bearing Test Apparatus," *Engineer*, vol. 207, January 30, 1959, pp. 200–201.

90 E. C. Ballard and E. E. Sommers, "New Fluoroester Lubricants for High-Temperature Applications," SAE Paper No. 9R, 1959.

91 G. H. Clark and D. A. Davidson, "Development, Testing, and Application of Petroleum-Based Launching Lubricants," *Journal of the Institute of Petroleum*, vol. 45, July, 1959, pp. 175–193.

92 T. M. Birchall, A. I. W. Moore, "Friction and Lubrication of Machine-Tool Slideways," *Scientific Lubrication*, vol. 10, November, 1958, pp. 26–31.

93 E. J. Weiter and A. O. Schmidt, "Frictional Behavior of Metals and Plastics," ASME Paper No. 58—A-243.

94 D. F. Denny, "Time Effects in the Static Friction of Lubricated Rubber," *Wear*, vol. 2, May, 1959, pp. 264–272.

95 H. Conn, "Stiction—What It Is and How It Occurs in Machine-Tool-Way Movements," *Machine and Tool Bluebook*, vol. 54, December, 1959, pp. 75–80.

96 W. H. Moore, "More Surface Polishing—Less Galling," *Product Engineering*, vol. 29, November 24, 1958, pp. 63–65.

97 P. R. Lancaster and G. W. Rowe, "Comparison of Boundary Lubricants Under Light and Heavy Loads," *Wear*, vol. 2, October, 1959, pp. 428–437.

98 M. Petronio, "Lubricants in Forming of Aluminum," *Lubrication Engineering*, vol. 14, December, 1958, pp. 510–522, 539.

99 "Pipe Coating Adds to Draw Die Life," *Steel*, vol. 144, February 23, 1959, pp. 82–83.

100 D. F. Eary, "Determining Effectiveness of Drawing Lubricants," *Tool Engineering*, vol. 43, August, 1959, pp. 83–90.

101 J. G. Wistreich, "Fundamentals of Wire Drawing," *Metallurgical Reviews*, vol. 3, no. 10, 1958, pp. 97–142.

102 J. R. McDowell, "Fretting of Hardened Steel in Oil," *Trans. ASLE*, vol. 1, 1958, pp. 287–295.

Metalworking Lubricants

103 J. G. Wistreich, "Fundamentals of Wire Drawing," *Metallurgical Reviews*, vol. 3, no. 10, 1958, pp. 97–142.

104 J. G. Wistreich, "A B C of Better Lubrication and Cooling in Steel Wire Drawing," *Wire and Wire Products*, vol. 34, November, 1959, pp. 1486–1489.

A Digest of the Literature for 1959-1960

105 P. R. Lancaster and G. W. Rowe, "A Comparison of Boundary Lubricants Under Light and Heavy Loads," *Wear-Usure-Verscheiss*, vol. 2, October, 1959, pp. 428–437.

106 G. G. Collins, "Borax in the Wire-Drawing Industry," *Wire and Wire Products*, vol. 34, August, 1959, pp. 968, 969, 1016.

107 E. L. White and P. D. Miller, "Chemical Conversion Coatings for the Lubrication of Titanium," *Lubrication Engineering*, vol. 14, November, 1958, pp. 479–482.

108 A. T. Stoddart, "A Compound System for Wire-Drawing Machines," *Wire and Wire Products*, vol. 34, April, 1959, pp. 458–460, 496.

109 S. Ya Veiler and V. I. Likhtman, "The Action of Lubricants in the Working of Metals Under Pressure," *Journal of Technical Physics of the USSR*, vol. 28, September, 1958, p. 2025. Translated in *Soviet Physics, Technical Physics*, vol. 3, April, 1959, pp. 1860–1868.

110 M. Petronio, "Lubricants in the Forming of Aluminum," *Lubrication Engineering*, vol. 14, December, 1958, pp. 510–522.

111 H. Wiegand and K. H. Kloos, "Einfluss der Oberflächengrenzschicht auf das Reiburgsverhalten austenitischer Werkstoffe bei der Kaltformung im Tiefziehverfahren," *Metalloberfläche*, vol. 13, August, 1959, pp. 229–233.

112 D. F. Eary, "Determining Effectiveness of Drawing Lubricants," *The Tool Engineer*, vol. 43, August, 1959, pp. 83–90.

113 G. Leclerc and J. Buffett, "Le Filage avec verre du Zirconium et des ses alliages," *Metaux Corrosion Industries*, vol. 34, no. 406, June, 1959, pp. 236–246.

114 J. Grindrod, "Lubrication of New Metals During Heat Treatment and Forming," *Scientific Lubrication*, vol. 11, Jan., 1959, p. 13.

115 H. K. Wikle, "Machining and Fabrication of Beryllium," *Machinery* (London), vol. 94, February 25, 1959, pp. 428–429.

116 B. Jaoul and B. Sejournet, "Lubrification de la deformation a chaud des metaux," *Metaux (Corrosion Industries)*, vol. 34, June, 1959, pp. 221–235.

117 R. J. Wilcox and P. W. Whitton, "The Cold Extrusion of Metals Using Lubrication at Low Speeds," *Journal of the Institute of Metals* (London), vol. 87, May, 1959, pp. 289–293.

118 J. C. Whetzel, Jr., and S. Rodman, "Improved Lubrication in Cold-Strip Rolling," *Iron and Steel Engineer*, vol. 36, March, 1959, pp. 123–131, discussion pp. 131–132.

119 W. Lueg and P. Funke, Jr., "Verschleissmessungen beim Ziehen von Stabstahl mit radio-aktivem Ziehwerkzeug," *Stahl und Eisen*, vol. 79, July 9, 1959, pp. 996–1002 (Henry Brutcher Translation No. 4230).

120 A. Z. Grebenshchikova and A. V. Kukarskikh, "Activated Lubricants for Cold Rolling Stainless Tubes," *Stal in English*, vol. 7, July, 1959, p. 539.

121 M. C. Shaw, N. H. Cook, and P. A. Smith, "The Cooling Characteristics of Cutting Fluids," American Society of Tool Engineers, Research Report No. 19, September 15, 1958.

122 M. C. Shaw, "On the Action of Metal Cutting Fluids at Low Speeds," *Wear-Usure-Verschleiss*, vol. 2, February, 1959, pp. 217–227.

123 S. J. Barber, "Selection of Soluble Cutting Fluids," *Machinery*, vol. 65, March, 1959, pp. 101–103.

124 R. D. Clouse and E. R. Hall, "Machinability or Cutting-Fluid Evaluation by Drilling Torque Test," *Lubrication Engineering*, vol. 14, November, 1958, pp. 483–487.

125 B. L. ten Horn, R. A. Schuermann, and J. Slaats, "Reaming Accuracy Improved With Coolants," *The Tool Engineer*, vol. 42, March, 1959, pp. 93–99.

126 "The Application of Cc De Cut to a Cri-Dan Threading," *Machinery* (London), vol. 94, January 7, 1959, pp. 37–40.

127 G. Pahltzsch and M. Magnussen, "Uber die technologischen Auswirkungen von Fett beim Bondschleifen," *Metalloberfläche*, vol. 12, June, 1958, pp. 177–181; October, 1958, pp. 308–312; December, 1958, pp. 372–375.

Automotive Lubricants

128 "An Old Lubricant! Honey and Sheep's Blood," *Scientific Lubrication*, vol. 11, April, 1959, p. 18.

129 J. D. Bartleson, "Let's Clear the Air on Modern Motor Oils," *SAE Journal*, vol. 67, May, 1959, p. 117.

130 "Motors Oils 1948–1958," *Scientific Lubrication*, vol. 11, January, 1959, pp. 9–10.

131 A. L. Lyman and F. W. Kavanagh, "A Decade of Progress in Motor Lubricants," API Division of Refining, Mid-year Meeting, New York, N. Y., May, 1959.

132 C. M. Floyd, "Lubrication of Natural Gas Engines," Mechanical Engineering, vol. 81, November, 1959, pp. 64–66.

133 "Small 2-Stroke Petrol Engines," *Scientific Lubrication*, vol. 11, March, 1959, p. 11.

134 L. E. Haas, "Lubrication of Air-Cooled and Water-Cooled 2-Stroke Cycle Engines," *Lubrication Engineering*, vol. 15, November, 1959, pp. 436–446, discussion pp. 446–449.

135 "Inboard Marine Engines," *Lubrication*, vol. 45, June, 1959, pp. 77–84.

136 A. Towle, "Problems Encountered in the Lubrication of Small 2-Stroke Engines," Institution of Mechanical Engineers, Paper for Meeting (London), February, 1959. (See also *Scientific Lubrication*, vol. 11, March, 1959, pp. 12–16, disc. pp. 18–20.)

137 A. Towle, "Some Factors Contributing Toward Successful Lubrication of Small European Two-Stroke Petrol Engines," SAE Preprint 66-T, for Summer Meeting, June, 1959. (See also *SAE Journal*, vol. 67, September, 1959, pp. 58–59.)

138 E. G. Ellis, "Problems and Progress in Two Stroke Engine Lubrication," *Scientific Lubrication*, vol. 11, September, 1959, pp. 12–18.

139 D. L. Pratt, G. M. Christie, E. F. Coxon, and J. R. Lodwick, "Fuels and Lubricants for the Trans-Antarctic Expedition," Institute of Petroleum, Paper for Meeting (London), October, 1958. (See also *Institute of Petroleum Journal*, vol. 45, February, 1959, pp. 19–40, discussion, pp. 40–41.)

140 D. L. Pratt, "Performance of Vehicles Under Trans-Antarctic Conditions," Institution of Mechanical Engineers, Paper for Meeting (London), April, 1959. (See also *Scientific Lubrication*, vol 11, May, 1959, pp. 26–27.)

141 "Engine Lubrication of European Cars," *Lubrication*, vol. 45, February, 1959, pp. 13–36.

142 A. J. Bozzelli, "Designing an Automatic-Transmission Fluid," SAE Preprint 13-T, for Meeting, Detroit, January, 1959 (Abstract in *SAE Journal*, vol. 6, April, 1959, p. 112).

143 "Automatic-Transmission Fluids," *Scientific Lubrication*, vol. 11, March, 1959, pp. 21, 24–25.

144 M. L. Haviland and J. J. Rodgers, "Friction Characteristics of Automatic-Transmission Fluids as Related to Transmission Operation," ASLE Paper No. 60 AM 6A1, for meeting, Cincinnati, Ohio, April, 1960.

145 A. Hundre, "A Look at the Problem of Gear Lubrication," ASLE Paper for first Gear Symposium, Chicago, Ill., January, 1959.

146 E. P. Cunningham and D. W. Dinsmore, "The New Look in Automotive Axle Gear Lubricants," *NLGI Spokesman*, vol. 23, March, 1960, pp. 475–480.

147 J. S. Elliott, N. E. F. Hitchcock, and E. D. Edwards, "Hypoid Gear Lubricants and Additives," Institute of Petroleum, Paper for Meeting (London), April, 1959 (*Institute of Petroleum Journal*, vol. 45, August, 1959, pp. 219–232, disc. pp. 233–235).

148 "Bus and Truck Lubrication," *Lubrication*, vol. 46, May, 1960, pp. 65–80.

149 J. W. Clark, R. E. Harvie, and E. L. Nash, "Development of Transaxle Fluid for the Chevrolet Corvair," SAE Preprint 117-B, for Annual Meeting, Detroit, Mich., January, 1960 (condensed in *SAE Journal*, vol. 68, January 1960, pp. 26–29).

150 R. K. Nelson and L. J. Valentine, "A Comparison of (Truck) Axle and Transmission Lubricant Requirements," SAE Preprint 192-C, for Summer Meeting, Chicago, Ill., June, 1960.

151 S. R. Calish, "The Practicality of a Common Transmission and Axle Lubricant," SAE Preprint 192-D, for Summer Meeting, Chicago, Ill., June, 1960.

152 R. E. Fletcher, "A Report on Transmission Lubricant Requirements," SAE Preprint 192-B, for Summer Meeting, Chicago, Ill., June, 1960.

153 W. A. Johnson, "Laboratory and Field Findings Pertaining to Axle Lubricants," SAE Preprint 192-A, for Summer Meeting, Chicago, Ill., June, 1960.

154 L. Raymond, "Co-operation in Research," *SAE Journal*, vol. 67, November, 1959, pp. 38–48.

155 L. Raymond, "Transaxle Lubrication," Institute of Mechanical Engineers, Meeting (London), October 1959 (Abstract in *Scientific Lubrication*, vol. 12, March, 1960, p. 28).

156 F. R. L. Daley, "Axle Lubricants: An Equipment Designer's View of Progress," API 25th Division of Refining Mid-Year Meeting, Detroit, May, 1960.

157 O. C. Bridgeman, "GL-4 Type Gear Lubricants and Their Service Performance," API 25th Division of Refining, Mid-Year Meeting, Detroit, Mich., May, 1960.

158 C. R. Noll, "Background and Current Status of the API GL-4 Designation for Automotive Lubricants," API 25th Division of Refining, Mid-Year Meeting, Detroit, Mich., May, 1960 (Reprinted in *NLGI Spokesman*, September, 1960, pp. 219–223.

159 A. F. Brewer, "The Detriments of Sludge," *Lubrication Engineering*, vol. 15, October, 1959, p. 395.

160 "Coking Tendencies of Lubricating Oils," *Petroleum* (London), vol. 22, January, 1959, p. 13–17.

161 S. R. Rouze and F. A. Forster, "A Service Evaluation of Deter-

gent Lubricating Oils Utilizing Electron Microscopy," *Lubrication Engineering*, vol. 16, May, 1960, pp. 222–227.

162 D. W. Golothan, "Influence of Lubricating Oil on Some Operating Problems of the 2-Stroke Gasoline Engine," Institution of Mechanical Engineers, Paper for Meeting (London), February, 1959. (See also *Scientific Lubrication*, vol. 11, March, 1959, p. 16–18.)

163 H. V. Lowther, G. H. Shea, and K. C. Kresge, "Lubrication Studies of Two-Cycle Gasoline Engines," SAE Paper 65-U, for Meeting, Atlantic City, N. J., June, 1959 (Abstract in *SAE Journal*, vol. 67, July, 1959, pp. 72–74).

164 T. H. Madden and W. R. Tuuri, "Used Oil Analysis—What Does It Tell?" SAE Paper S-164, for Meeting, Cleveland, Ohio, May, 1959 (Abstract in *SAE Journal*, vol. 67, August, 1959, p. 53).

165 "Analysis of Deposits," *Lubrication*, vol. 45, January, 1959, pp. 1–12.

166 O. L. Spilman and W. F. Ford, "Motor-Oil Evaluation in Low-Duty, High-Output Engines," SAE Paper 126-T, for Meeting, October, 1959 (Abstract in *SAE Journal*, vol. 68, March, 1960, pp. 68–72).

167 George H. von Fuchs, "The Rotary Bomb Oxidation Test," *Lubrication Engineering*, vol. 16, January, 1960, pp. 22–26, disc. pp. 27–31.

168 D. T. Rogers and F. L. Jonach, "Mechanism of Intake-Valve Underside Deposit Formation," SAE Paper 106-C, for Meeting, November, 1958 (Abstract in *SAE Journal*, vol. 67, January, 1959, p. 39).

169 E. H. Loeser, R. C. Wiquist, and S. B. Twiss, "Cam and Tappet lubrication IV, Radioactive Study of Sulfur in the EP Film," ASLE Paper 59 AM 1C4, for meeting, Buffalo, N. Y., April, 1959.

170 R. C. Wiquist, S. B. Twiss, and E. H. Loeser, "Distribution of an EP Film on Wear Surfaces," Paper 59 LS-12 for ASLE-ASME Joint Lubrication conference, New York, N. Y., October, 1959.

171 E. S. Reynolds, "Surface Active Agents as EP Conditioners," ASLE Paper, 60 AM 3B4, for Meeting, Cincinnati, Ohio, April, 1960 (Abstract in *Lubrication Engineering*, vol. 16, April, 1960, pp. 175–176).

172 J. Messina, Louise Peale, B. Ackerman, R. Sasin, and D. Swern, "Evaluation of Long-Chain Phosphorous Compounds on Lubricity Additives," ASLE Paper 59 AM 3B2, for Meeting, Buffalo, N. Y., April, 1959 (Abstract in *Lubrication Engineering*, vol. 15, April, 1959, p. 170).

173 R. Byrne, "Behavior of Viscosity-Index Improver in Lubricating Oil," ASLE Paper 59AM3Cl, for meeting, Buffalo, N. Y., April, 1959 (Brief in *Lubrication Engineering*, vol. 16, April, 1960, pp. 191–192).

174 A. G. Arend, "Requirements of Additives for Hydraulic and Lubricating Oils," *Petroleum*, vol. 22, December, 1959, pp. 435, 437.

175 C. J. C. Vineall and A. Taylor, "Molybdenum Disulphide," *Scientific Lubrication*, vol. 11, April, 1959, pp. 32–35.

176 E. G. Curphur, "Developments in Lubricant Additives," *Scientific Lubrication*, vol. 12, June, 1960, pp. 26, 27.

177 R. Larson, "Corrosion and Wear-Reducing Effect of Zinc Dithiophosphate in Modern Motor Oils," *Schweizer Archiv für angewandte Wissenschaft und Technik*, vol. 25, 1959, p. 54–61.

178 E. H. Kadmer, "Characteristics and Limitations of Chemical Additives for Lubricants" (in German), Friction, Lubrication & Wear Seminar, Lucerne, Switzerland, September, 1959 (Abstract in *Erdol und Kohle*, vol. 12, December, 1959, pp. 1006–1007).

179 V. Oakes, "A Laboratory Evaluation of Extreme-Pressure Additives," *Scientific Lubrication*, vol. 11, December, 1959, pp. 16, 18–24.

180 K. V. Ingold and I. E. Puddington, "Mechanisms of Inhibition in Oil Oxidation," *Industrial and Engineering Chemistry*, vol. 5, October, 1959, p. 1319.

181 S. R. Sprag and R. G. Cunningham, "Chemical Additives Control of Frictional Characteristics of Lubricants," *Industrial and Engineering Chemistry*, vol. 51, September, 1959, p. 1047.

182 J. W. Savin, "What Is Needed in Two-Cycle Engine Oil," *SAE Journal*, vol. 67, August, 1959, pp. 62–63.

183 L. O. Bowman and R. W. Burchell, "Two-Cycle Engines Prefer Ashless Detergent," *SAE Journal*, vol. 67, July, 1959, pp. 38–40.

184 "Supplement 1 Oil," *Automobile Engineer*, vol. 49, March, 1959, pp. 107–109.

185 N. A. Hunstad, R. A. Wilkins, R. E. Osborne, and E. D. Davison, Jr., "Developing Transaxle Fluid," SAE Preprint 117-A, for Meeting, Detroit, Mich., January, 1960 (Abstract in *SAE Journal*, vol. 68, February, 1960, pp. 64–69.)

186 T. H. Randall, R. E. Andrus, F. S. Fein, and H. D. Kluge, "Lubricant Additive Action in Combating Low Temperature Wear in Automotive Engines," SAE Paper 107-A, for Meeting, November, 1958 (Abstract in *SAE Journal*, vol. 67, March, 1959, p. 103).

187 C. Z. Kaplan and B. A. Sesekin, "Influence of Ferric Naphthenate on the Thermal Breakdown of Polymers in Thickened Oils" (in Russian), *Khim. Tekh. Topliv. Masel*, February, 1959 (2), pp. 34–37 (Abstract in *Institute of Petroleum Journal*, vol. 45, September, 1959, p. 189A).

188 K. I. Klimov and P. P. Zarudnii, "Mechanical Breakdown of Solutions of Polyisobutane in Mineral Oils" (in Russian), *Khim. Tekh. Topliv. Masel*, February, 1959 (2), pp. 37–43 (Abstract in *Ibid.*, pp. 189A, 190A).

189 "Additives—A Way to Produce Quality," *Petroleum Refiner*, vol. 38, September, 1959, pp. 203–226.

190 J. M. Musselman and S. M. Darling, "The Contribution of Polymers to Oil Properties Important to Engine Lubrication," ASLE Paper 59 AM 3B3, for Meeting, Buffalo, N. Y., April, 1959 (Abstract in *Lubrication Engineering*, vol. 5, April, 1959, p. 165).

191 J. Grindrod, "U. S. Tests With Multigrade Oils," *Petroleum* (London), vol. 23, January, 1960, pp. 21–22.

192 L. D. La Croix and M. L. Kalinowski, "One Test Evaluates Motor-Oil Contribution to Combustion Deposits," SAE Paper 126-U for Meeting, Chicago, Ill., October, 1959 (Abstract in *SAE Journal*, vol. 63, March, 1960, p. 94).

193 A. E. Brenneman and E. D. Nostrand, "Multigrade Dispersant Detergent Oils—Best Way to Keep Engines Clean," SAE Paper 126-V for Meeting, Chicago, Ill., October, 1959 (Abstract in *SAE Journal*, vol. 68, March, 1960, p. 6).

194 "Radioisotopes Applied to Engine-Wear Studies," *Scientific Lubrication*, vol. 11, October, 1959, pp. 20, 21, 24–27.

195 J. Thiery, "Piston Ring Wear on the Petter AVI Diesel Engine Determined by the IFP-RA3 Method" (in French), *Revue de l'institut francais du pétrole*, vol. 14, 1959, pp. 745–754.

196 J. Thiery, "Radiotracers in Piston-Ring Wear," SAE Paper 66-V, for Summer Meeting, Atlantic City, N. J., June, 1959 (Briefed in *SAE Journal*, vol. 67, October, 1959, pp. 68–69; see also *Wear*, vol. 3, March-April, 1960, p. 160).

197 "French Improve Engine-Wear test," *Petroleum Week*, vol. 9, November 13, 1959, pp. 94, 99.

198 B. A. Robbins, P. L. Pinotti and D. R. Jones, "Use of Radioactive Trace to Determine Effect of Operating Variables on Engine Wear," SAE Paper 72-U, for Summer Meeting, Atlantic City, N. J., June, 1959.

199 J. J. Furey and J. F. Kunc, "Radioisotopes in Fuels and Lubricants Research," Paper 6, Section X, Fifth World Petroleum Congress, New York, N. Y., May-June, 1959 (Abstract in *Petroleum* (London), vol. 22, January, 1960, p. 32).

200 H. Halliwell, "Radiotracers Reveal Engine Wear During Detergent Oil-Filtration Study," SAE Paper 72-T, for Summer Meeting, Atlantic City, N. J., June, 1959.

201 R. Abowd, Jr., "Causes of Piston Ring Wear by Radiotracer Technique," SAE Paper 8-U, for Annual Meeting, January, 1959.

202 W. C. Arnold. V. T. Stonehocker, W. J. Braun, and D. N. Sunderman, "Radioactive Cylinders—A Tool for Wear Research," *SAE Journal*, vol. 68, May, 1960, pp. 70–75.

203 "Radioactive Liner Used in Diesel Wear Test," *Diesel Power*, vol. 37, May, 1959, p. 27.

204 R. C. Wiquist, "Radioisotopes Aid Surface-Phenomena Studies," *SAE Journal*, vol. 67, June, 1959, p. 100.

205 E. Pietschmann, "Measuring the Wear of Internal-Combustion Engines by Means of Emission Spectroscopy" (in German), *Wear*, vol. 2, August, 1959, pp. 335–348.

206 L. H. Dawtrey, "Problems of High Oil Consumption and Cold Starting," *Scientific Lubrication*, vol. 11, December, 1959, pp. 31–32.

207 E. H. Loeser, "Bench Test of Cam and Tappet Wear in Additive Oils," ASLE Paper 60 AM 4C2, Annual Meeting, April, 1960.

208 D. W. Gow, "Mileage Cuts Wear Protection of MS Oils," SAE Paper S-233, Meeting, December, 1959 (Abstract in *SAE Journal*, vol. 68, May, 1960, p. 86.

209 G. H. Robinson, R. F. Thomson, and F. J. Webbere, "The Use of Bench Wear Tests in Material Development," SAE Preprint 17-S, for Meeting, Detroit, Mich., January, 1959 (Abstract in *SAE Journal*, vol. 67, April, 1959, pp. 80–83).

210 M. M. Kruschov, "A New Method for Determination of Wear of Machine Parts," Institute for the Study of Machines, Moscow, Russia, *Wear*, vol. 3, January, 1960, pp. 60–71.

211 H. D. Lees, "Statistics on Cylinder Wear in Marine Diesel Engines," *Ingeniren-International*, Edition 2, pp. 76–88; *Wear*, vol. 2, May, 1959, pp. 273–295 (Briefed in *Scientific Lubrication*, vol. 11, September, 1959, p. 26).

212 J. J. Geissler, "Statistical Analysis of Lubricant Tests," ASLE Preprint 60 AM 6A4, for meeting, April, 1960 (Abstract in *Lubrication Engineering*, vol. 16, April, 1960, p. 180).

213 V. C. Vanderbilt and C. L. Zimmer, "Hi Fi Dynamometer Testing by Tape Programming," SAE Preprint 69 V, for Meeting, June, 1959 (Abstract in *SAE Journal*, vol. 67, October, 1959, p. 129).

214 K. A. Frassa and C. R. Small, "Warm-Up Test Instrumentation in the Laboratory," SAE Preprint 6-S, for Meeting, January, 1959 (Abstract in *Institute of Petroleum Journal*, vol. 45, June, 1959, p. 119A.

215 L. W. Sproule, T. F. Lonstrup, and W. C. Pattenden, "Field Tests

A Digest of the Literature for 1959-1960

of Automotive Lubricants," SAE Paper 86-U for Meeting (Vancouver), August, 1959 (Abstract in *SAE Journal*, vol. 67, November, 1959, p. 6).

216 A. L. Williams and E. A. Obberight, "The Oxidation of Lubricating Oils at High Temperatures," ASLE-ASME Joint Lubrication Conference, Paper 59—LUB-8, for Meeting, October, 1959 (Abstract in MECHANICAL ENGINEERING, vol. 81, December, 1959, pp. 96–97).

217 E. G. Foehr and S. R. Calish, "Correlation of Bench Oxidation Tests with Transmission Test Performance of Automatic-Transmission Fluid," SAE Paper 13-S, for Meeting, Detroit, January, 1959 (Abstract in *Scientific Lubrication*, vol. 11, March, 1959, pp. 24-25).

218 H. E. Dean and C. M. Stendahl, "Oxidation Stability, Shear Stability, and Rubber-Swell Properties of Automatic-Transmission Fluids," SAE Preprint 124-V, for Meeting, Chicago, Ill., October, 1959 (Abstract in *SAE Journal*, vol. 68, February, 1960, pp. 58–59. Briefed in *Scientific Lubrication*, vol. 11, December, 1959, p. 28).

219 W. H. Kite, Jr., and E. F. Koenig, "Evaluating Automatic-Transmission Fluids," SAE Preprint 13-R, for Meeting, Detroit, Mich., January, 1959 (Abstract in *SAE Journal*, vol. 67, March, 1959, p. 107).

220 "Evaluating Automatic Transmission Fluids," *Lubrication*, vol. 45, April, 1959, pp. 53–64.

221 T. W. Selby, "Automatic-Transmission Fluid Viscosity at Low Temperature and Its Effect on Transmission Performance," SAE Preprint 124-T, for Meeting, Chicago, Ill., October, 1959. Briefed in *Scientific Lubrication*, vol. 11, December, 1959, pp. 28–29.

222 R. E. Crosthwait and W. F. Greenawalt, "Automatic-Transmission Fluids Low-Temperature Viscosity Studies," SAE Paper 124-U, for Meeting, Chicago, Ill., October, 1959. Abstract in *SAE Journal*, vol. 67, December, 1959, pp. 139, 145.

223 M. Brunner and H. Ruf, "The Effects of Batteries and Lubricants on the Operation of Diesel Engines at Low Temperatures," Institution of Mechanical Engineers, Paper for Meeting (London), December, 1959. Abstract in *Scientific Lubrication*, vol. 12, January, 1960, pp. 27, 28, 30, 31.

224 M. P. Volarovich, "An Investigation of Piston-Cylinder and Shaft Bearing Friction at Low Temperatures," *Wear*, vol. 2, February, 1959, pp. 203–216. Abstract in *Journal of the Institute of Petroleum*, vol. 45, June, 1959, p. 118A.

225 A. de Faro Barros and A. Dyson, "Piston-Ring Friction-Rig Measurements With Low-Viscosity Oils," *Institute of Petroleum Journal*, vol. 46, January, 1960, pp. 1–15, discussion, pp. 15–18.

226 L. O. Bowman and M. W. Savage, "Laboratory Methods for Predicting Silver-Bearing Performance of Lubricating Oils," *Scientific Lubrication*, vol. 12, April, 1960, pp. 30, 32.

227 J. R. Belt and L. G. Schneider, "Are the Navy's Engine Oils Good Enough for Their Latest Diesels?" SAE Preprint 110-A, for Meeting, Detroit, Mich., January, 1960.

228 F. R. Bryan, J. C. Neerman, and J. E. Hinsch, "Metallic Tracer Method for Determining Lubricant in Engine Exhaust," SAE Preprint 194-C, for Meeting, Chicago, Ill., June, 1960 (Abstract in *SAE Journal*, vol. 68, June, 1960, pp. 135–136).

229 M. Pobereskin, D. N. Sunderman, and E. J. Fithian, "What Determines Engine Oil Consumption," *Atomic World*, March 10, 1959, pp. 110–111 (Abstract in *Wear*, vol. 3, January, 1960, p. 74).

230 E. S. Starkman, "A Radioactive-Tracer Study of Lubricating-Oil Consumption," SAE Preprint 194-B, for Meeting, Chicago, Ill., June, 1960.

231 R. M. Matveevsky, "Influence of Low Temperatures on the Lubricating Capacity of Mineral Oils," *Wear-Usure-Verschleiss*, vol. 2, May, 1959, pp. 315–317 (Abstract in *Institute of Petroleum Journal*, vol. 45, August, 1959, pp. 164A, 165A).

232 F. Hirano and S. Yamamoto, "Four-Ball Test on Lubricating Oils Containing Solid Particles," *Wear-Usure-Verschleiss*, vol. 2, August, 1959, pp. 349–363 (Abstract in *Scientific Lubrication*, vol. 11, September, 1959, p. 28.

233 J. N. Augustin, "Friction and Lubrication in Engines, Particularly with the Addition of Colloidal Graphite," *Deut. Rheol. Ges. Kolleg.*, Berlin, Germany, May, 1959; *Wear*, vol. 3, March-April, 1960, pp. 114–121.

234 N. T. Meckel and R. D. Quillian, Jr., "Study of Gear Thermal-Oxidative Degradation Phenomena," SAE Paper, 38-T, for Meeting, Detroit, January, 1960 (Abstract in *SAE Journal*, vol. 68, May, 1960. pp. 60–62).

235 E. A. Ryder, "The Gear Rig as an Oil Tester," *Lubrication Engineering*, vol. 15, August, 1959, pp. 318–322. Disc., pp. 322–324.

236 A. J. De Ardo and L. B. Sargent, Jr., "A Laboratory Rating Method for Extreme-Pressure Gear Lubricants," *Lubrication Engineering*, vol. 15, September, 1959, pp. 367–371.

237 H. R. Smith, "The Wright Air Development Center Gear-Lubrication Research and Development Program," *Lubrication Engineer*, vol. 15, July, 1959, p. 290–294.

238 W. C. Brandow, "Performance of EP Gear Lubricants in the Rear Axles of an Over-the-Road Truck Fleet," ASLE Preprint 60 AM 3A3, for Meeting, Cincinnati, Ohio, April, 1960 (Abstract in *Lubrication Engineering*, vol. 16, April, 1960, p. 175).

239 T. P. Sands, "Development of New Gear-Lubrication Specification," SAE Paper S-196, for Meeting (Mid-Continent Section), April, 1959.

240 W. A. Johnson, "Lubricating Heavy-Duty Commercial Drive Axles," SAE Paper S-197, for Meeting (Mid-Continent Section), April, 1959.

241 W. Gibb and H. Gibson, "Determination of Acidity in Dark Lubricating Oils," *Petroleum* (London), vol. 22, July, 1959, pp. 257–262.

242 J. W. Barger, C. C. Bolze, R. L. Hughes, and T. M. Medved, "Rapid Determination of Heat Capacity of Liquids Over Extended Temperature Range," *Lubrication Engineering*, vol. 16, March, 1960, p. 105.

243 "Photometric Method for Determination of Carbonaceous Matter in Diesel-Engine Oil," *Scientific Lubrication*, vol. 11, January, 1959, p. 23.

244 J. E. Barney, J. G. Bergmann, and W. G. Tuskan, "Rapid Determination of Phosphorous in Motor Oils and Additives," *Analytical Chemistry*, vol. 31, August, 1959, pp. 1394–1396.

245 A. Schilling and J. Marlot, "Rapid Tests for Oils in Service," *Bullatin de l'association technique de Petrole*, 1959, pp. 407–422.

246 R. A. Porter and J. F. Johnson, "Gas Chromatographic Determination of Fuel Dilution in Lubricating Oils," *Analytical Chemistry*, vol. 31, May, 1959, pp. 866–869.

247 P. G. Elsey, "Gas Chromatographic Determination of Dissolved Oxygen in Lubricating Oil," *Analytical Chemistry*, vol. 31, May, 1959, pp. 869–870.

248 T. C. Yao and F. W. Porsche, "Determination of Sulfur and Chlorine in Petroleum Liquids by X-Ray Fluorescence," *Analytical Chemistry*, vol. 31, December, 1959, pp. 2010–2012.

249 D. Winston, "Spectrometer Directs Maintenance Program," *Control Engineering*, vol. 7, June, 1960, pp. 32–34.

250 A. L. Hensley and J. E. Barney, "Rapid Determination of Barium, Calcium, and Zinc in Lubricating Oils and Additives," Paper 8B-9, for American Chemical Society Meeting, Cleveland, Ohio, April, 1960.

251 B. Bernelin, "Electrochemical Method for Study of Micellar State of Detergent Lubricating Oils," *Institut Francais de Petrole et Annales des Combustibles Liquids Revue*, vol. 14, October, 1959, pp. 1295–1306.

252 A. B. Two, "Disposal and Conservation of Lubricating Oil by Re-refining," ASLE Paper 60 AM 2A1, for Meeting, Cincinnati, Ohio, April, 1960 (Abstract in *Lubrication Engineering*, vol. 16, April, 1960, p. 173).

253 L. C. Atchison and R. McBrian, "Lubrication and Its Effect on Maintenance," SAE Paper 84 T, for Meeting, Vancouver, August, 1959.

254 L. S. Echols and F. J. Cordera, "Multi-Engine Facilities—A Tool for Fuel and Lubricant Research," SAE Paper 69 T, for Meeting, Atlantic City, N. J., June, 1959.

255 O. G. Lewis, R. R. Risher, Jr., and J. A. Wilson, "Eight-Lane Dynamometer Highway," SAE Paper 69 U, for Meeting, Atlantic City, N. J., June, 1959.

256 H. Jennings, "Oil-Drain Periods," SAE Paper S-165, for Meeting (Metropolitan Section) March, 1959 (Abstract in *SAE Journal*, vol. 67, June, 1959, p. 106).

257 J. W. Lane, "Oil Marketer Looks at Crankcase-Oil-Drain Periods," SAE Paper S-166, for Meeting (Metropolitan Section), March, 1959 (Abstract in *SAE Journal*, vol. 67, June, 1959, p. 106).

258 J. O. Sibley, "Crankcase-Oil Drain Period from the General Public Viewpoint," SAE Paper S-167, for Meeting (Metropolitan Section), March, 1959.

259 K. F. Glynn, "The Philosophy of the Passenger-Car Manufacturer's Recommendation for Changing Lubricating Oil," SAE Paper S-168, for Meeting (Metropolitan Section), March, 1959.

260 "When to Change Oil Still a Battle Royal," *SAE Journal*, vol. 67, July, 1959, pp. 80–108.

261 D. C. Bardy, "How Often Should Engine Oil Be Drained?" SAE Presentation (Baltimore Section), 1959 (Abstract in *SAE Journal*, vol. 67, December, 1959, p. 78).

262 R. Cubiciotti, "Oil-Change Period No Problem," API Lubrication Committee Meeting, Bedford Springs, 1960 (Abstract in *Oil and Gas Journal*, vol. 58, May 23, 1960, p. 77).

263 C. C. Moore, "Proposes Simplified Oil-Changing Practice," SAE Presentation, So. Calif. Section, 1960 (Abstract in *SAE Journal*, vol. 68, June, 1960, pp. 96, 126).

264 "API Modifies 1000-Mile Lube Stand," *Petroleum Week*, vol. 9, July 31, 1959, pp. 12–13.

Abstracts and Comments Based on Current Periodicals and Events

D. FREIDAY
Associate Editor

BRIEFING THE RECORD

Motorized Wheel

AN ELECTRIC traction motor, mounted in the rim of each wheel and bolted to the side of the vehicle, completely eliminates the need for transmission, differentials, and drive shafts in General Electric's new drive concept for off-highway vehicles.

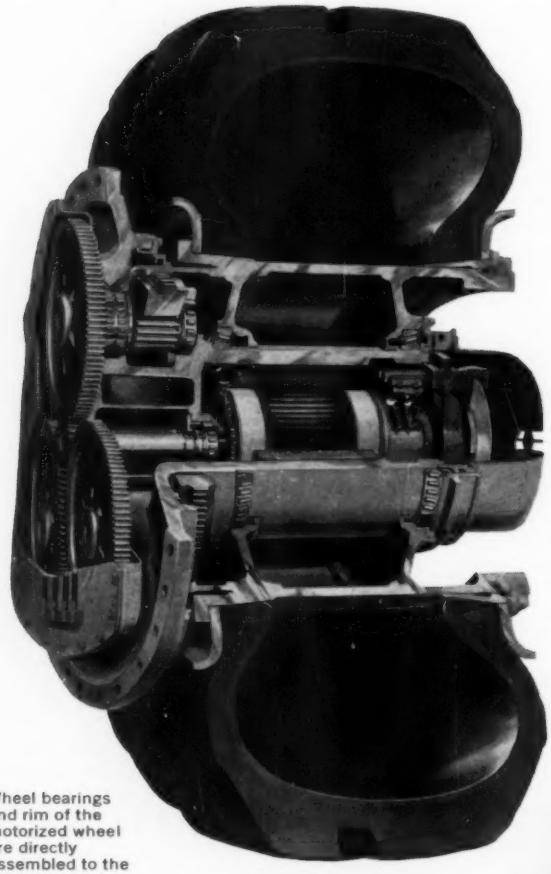
The motor is a conventional G-E traction type, d-c series-wound machine. All coils throughout the motor are heavily insulated with mica, glass, and modified silicone binding. The extra-large commutator of silver-copper alloy segments withstands the stress and high temperatures of heavy overloads encountered in off-highway service.

Available as replacement as well as original equipment, the motorized wheel provides increased maneuverability, increased gradability, maximum horsepower utilization, increased traction, and longer tire life. It is adaptable for vehicles with rim sizes from 29 to 49 in.

The optimum application of the G-E motorized wheel, made by the company's Locomotive and Car-Equipment Department, Erie, Pa., is on 4-wheel-drive vehicles where the full weight of the vehicle is available for traction in rough going.

The motorized wheel can be powered by a diesel or gas-turbine-driven generator or by overhead trolley lines. In diesel-electric applications, power is supplied from a multiple-field d-c generator directly coupled to the diesel engine. Generator control is secured through the inherent characteristics of its field design. A separate exciter is supplied to minimize the amount of battery power required for excitation control.

The motorized wheels and generator are cooled with forced clean air. The ventilating air, supplied by centrifugal self-cleaning blowers, circulates through the arma-



Wheel bearings and rim of the motorized wheel are directly assembled to the unitized-wheel mounting flange and motor frame. A disk brake is mounted on the outboard end of the armature shaft.

The use of four motorized wheels on Lectra Haul completely eliminates the need for any transmission, differentials, or drive shafts

ture punchings, field coils, and commutators to allow the motors to carry heavy loads without overheating and to run at temperatures well below maximum insulation limits.

Ventilating air for the traction motors and generator can be supplied by mechanically driven blowers operating from an engine power take-off or the generator tail shaft. If electrically driven blowers are desired, the power may be taken from the traction generator or from the auxiliary electric-power system for lights, starting, control, and so forth.

The patented motorized wheel utilizes the magnet frame of the motor to support the vehicle as well as to serve as the magnetic structure of the motor, thus keeping over-all vehicle width to a minimum.

The wheel bearings and rim are directly assembled to the unitized wheel-mounting flange and motor frame. The armature shaft is supported by grease-lubricated sealed bearings and is internally splined to drive a "sun" pinion shaft. The floating sun pinion drives three high-speed, fixed-center "planet" gears. The low-speed planets, on the same shaft, drive the final reduction ring gear, which is attached to the wheel rim.

A disk brake for emergency, parking, and low-speed operation applications is mounted on the outboard end of the armature shaft. The brake and the motor brushes are readily accessible for inspection and maintenance by removing the lightweight hub cap.

A 65-ton unit called Lectra Haul and built by Unit Rig and Equipment Company of Tulsa, Okla., has a 700-hp Cummins VT-12 diesel engine which operates through a G-E GT-594 generator to provide energy to the motorized wheels.

In descending grades, braking is accomplished electrically by dissipating the kinetic energy of the vehicle as heat in resistors. This is done by connecting the traction motors as generators and loading them on braking resistors. This type braking effort provides extremely high braking rates without fading or mechanical wear. In addition to the dynamic braking effort, the hydraulically operated disk brake may be utilized simultaneously.

Full control of traction and braking effort over the vehicle's speed ranges makes large-vehicle handling easy and safe. Drive-system maintenance is drastically cut with components designed to have a minimum operating life of 150,000 miles before requiring major electrical overhaul. Speeds up to 35 mph are possible.

Joining Copper Parts

A NEW technique for joining copper to copper and certain alloys to copper has been developed by Chase Brass and Copper Company, a subsidiary of Kennecott Copper Corporation. Cost savings, easier production methods, and improved products are among the advantages which may result from the new technique.

In the Chase process two or more copper components can be joined together with a homogeneous bond which is a strong as or stronger than the base metal. A special coating on the metal surface diffuses into the parts to be joined and, under proper conditions, produces a bond without an interface. Joints made in this manner retain virtually all of the high electrical and thermal conductivity of copper. This will be especially advantageous for many electrical and electronic applications.

Tests on diffusion-bonded joints have shown them to be markedly superior to soft-soldered joints in respect to tensile, shear, and fatigue properties. Corrosion resistance in many media is also expected to be higher.

Use of copper strip, rod, wire, and tube which are coated for diffusion bonding by the Chase process may lead to production economies through simplification of assembly operations. The integral coating makes it unnecessary to apply the joining material by any of the conventional methods. This may make it more practical to automate joining operations which are now manual.

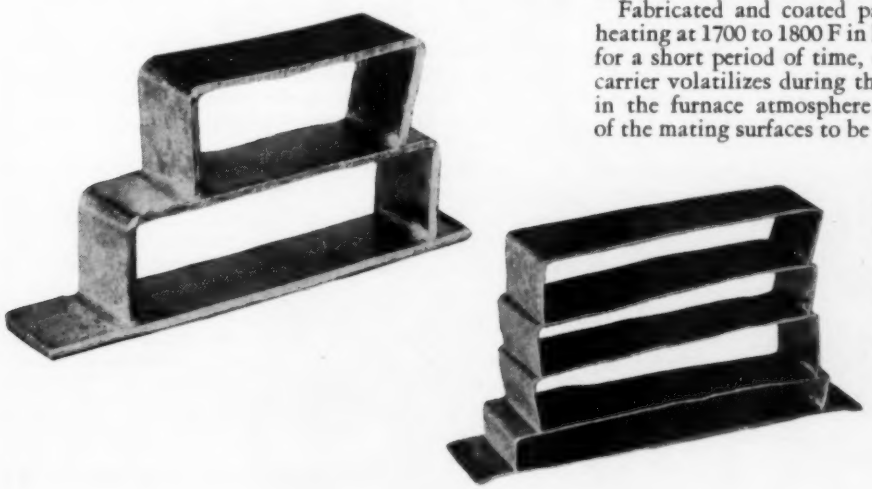
Possible fields of application for the Chase diffusion-bonding process include electric motors, generators, transformers, switchgear, relays, control equipment, electronic tubes, high-frequency power generators, microwave devices, semiconductors, and heat exchangers.

The new technique will also provide substantial savings in some applications where costly joining materials have heretofore been used.

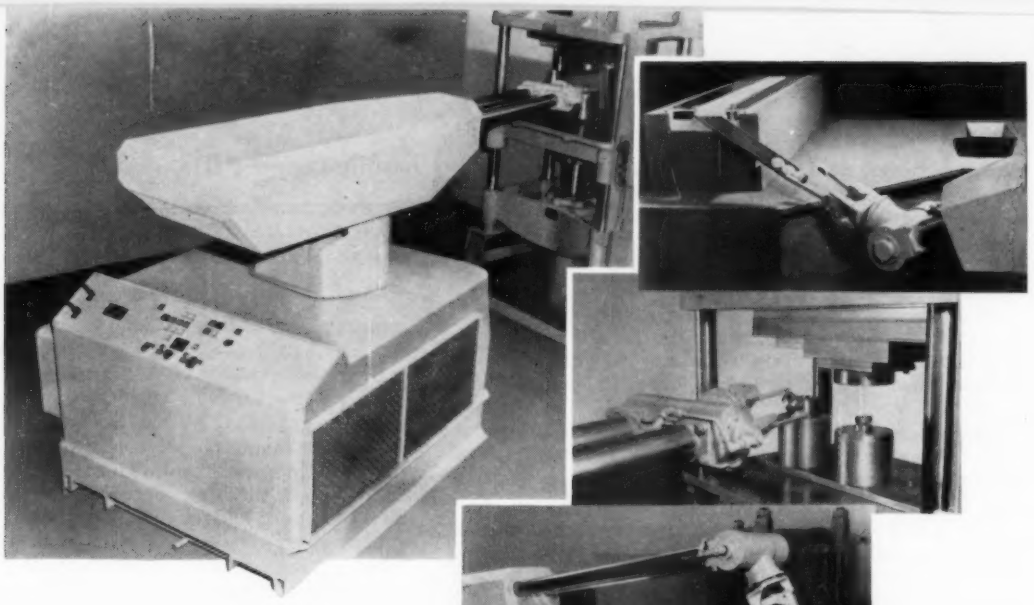
The coating which effects diffusion bonding of fabricated parts can be applied to copper strip before it is rolled to finished gage. It is also practical to coat fabricated parts. Several types of bonds can be made, namely, complete diffusion, braze, and combined diffusion and braze. One type may be more suitable for a specific application, but all make highly satsifactory joints.

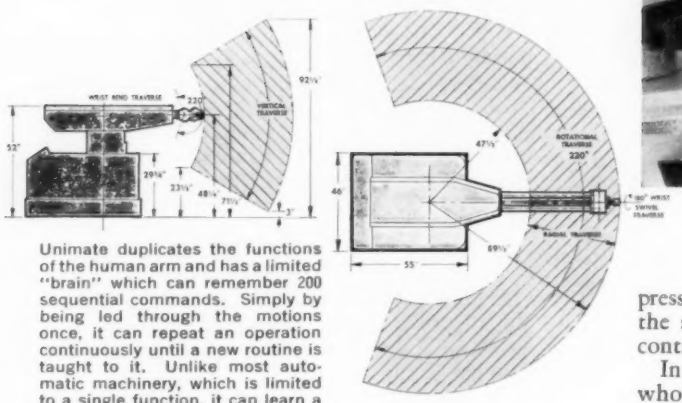
Coated strip can be annealed in a nonoxidizing atmosphere at moderate temperatures and fabricated by many of the usual techniques such as blanking, deep drawing, bending, or stamping to the desired shape without adversely affecting the coating. The coated metal requires only reasonable care in handling.

Fabricated and coated parts are diffusion bonded by heating at 1700 to 1800 F in hydrogen or inert atmosphere for a short period of time, ordinarily 5 to 15 min. The carrier volatilizes during this exposure and is dissipated in the furnace atmosphere. Reasonably good contact of the mating surfaces to be joined is required.



Copper parts are bonded by the volatilization of a coating on the metal surfaces which diffuses into the parts to be joined. Under proper conditions it produces a bond without an interface. The strip at left is 0.005 in. thick, that at right 0.025 in.





Unimate duplicates the functions of the human arm and has a limited "brain" which can remember 200 sequential commands. Simply by being led through the motions once, it can repeat an operation continuously until a new routine is taught to it. Unlike most automatic machinery, which is limited to a single function, it can learn a variety of jobs.

Unimation

UNIMATE, a device whose arm duplicates the functions of the human arm and a "brain" which can remember 200 sequential commands, has been developed by Consolidated Controls Corporation, Bethel, Conn., a subsidiary of Consolidated Diesel Electric Corporation.

Unimate "learns" to perform a task by simply being led through the motions once. Thereafter, it can repeat the operation continuously until a new routine is taught to it. With an assortment of hands it can do a variety of jobs. The same Unimate might be assembling parts one month, feeding a lathe the next, operating a welding gun the third month, feeding a forging press the fourth, loading a conveyer the fifth, operating a punch press the sixth. Every hazardous, hot, noisy, or tedious job is a prime prospect for Unimation.

In a demonstration, Unimate unerringly picked up lead billets one by one and then placed them on a moving conveyer belt. In a simulation of heavier work handling, Unimate moved 2-ft, 16-lb steel cylinders from the bottom of one chute and placed them on the top of another, as might be required in loading a heat-treating furnace.

Used to operate a forging press, Unimate removed a metal billet from a conveyer chute, carefully placed it on a die in the press, and then actuated the press. After the press had closed and opened, Unimate picked up a new billet and put it on the first die. After actuating the press again, the robot removed the finished piece from the second die and dropped it in a box. The routine continued automatically.

In a demonstration of its ability to learn, onlookers, who had never seen Unimate before, easily taught simple tasks to the machine. Thereafter, the machine could automatically repeat the routines, either on command or continuously.

Unlike automatic machinery which is capable of doing only one job and often becomes obsolete before it pays for itself, Unimate avoids obsolescence because it can be retaught another job when the current job is completed.

It can be used to automate processes formerly ruled out by cost factors. Through continuous utilization, not necessarily on a single job, a machine can pay for itself in from two to three years of useful life. Design life is 40,000 operating hr with 2500-hr overhaul recommended.

A boxlike base contains all of the control and operating mechanisms for the $5 \times 4 \times 4\frac{1}{2}$-ft-high machine weighing 2700 lb. There are no separately mounted peripheral devices. From the pedestal a central column rises. From the top of the column Unimate's arm extends.

Hydraulically operated, the arm can telescope in length from 3 to 7 ft; in a horizontal plane it can sweep an arc of 220 deg, in a vertical plane, 60 deg. With its arm fully extended it can reach from within 4 in. of the floor to 90 in. above the floor. All told, it can grasp objects within a swept volume of 350 cu ft.

A "wrist" at the end of the arm can both bend and rotate. The wrist joint is terminated in a hand designed to grasp a particular object. Usually, this hand bears some resemblance to a lobster claw. Since the hand is pneumatically operated, the pressure with which it grasps an object can be controlled by varying the air

pressure supplied. Thus Unimate can handle fragile objects gently as well as grasp heavy objects firmly. Maximum clamping force is 180 lb at the end of 4-in. fingers.

The "brain" is a patented magnetic memory drum, Dynastat, which, unlike previously developed drums, can be "read" while standing still. Its surface consists of segments of magnetic material which can be either magnetized or demagnetized in a pattern conforming to instructions recorded when the arm is being led through a task for the first time. Since the drum does not have to rotate to present its readings, it simply steps from one position to the next and waits for a signal that the arm has assumed a corresponding position before stepping on to present the next set of positioning instructions.

In addition to controlling the arm and hand, the memory drum also can control external devices. For example, in feeding a punch press it can actuate the press after the workpiece has been placed on the press by Unimate and the hand has withdrawn a safe distance.

Unimate can handle 25-lb objects faster than a human being and 75-lb objects at a slower rate, still faster than human.

Entirely self-contained, the unit will be sold on a ready-to-operate basis. Power requirements are 440 volts, 3-phase, 60-cps, 11.0 kva. The owner simply moves it into position with a fork-lift truck, plugs it in, teaches it its first chore, and walks away. When he wants it to operate another machine or to handle material in another portion of his factory, he simply moves it by means of a fork lift to a new location.

At the moment, Consolidated Controls has completed shaking down its first unit and is in the midst of a pilot run of production units which will be placed in selected spots in industry for further seasoning. On completion of the pilot run, the company will accept orders for the units at $25,000 each.

McCormick Place Exposition Hall

In addition to 320,000 sq ft of exhibition space, McCormick Place, Chicago's new mammoth, 10-acre exposition hall contains two theaters, a restaurant for 650 diners, a cafeteria that serves 1800 meals an hour, and 23 meeting rooms seating from 200 to 2000 each.

It is designed to hold as many as 30,000 persons at one time. To meet the varying load conditions with changes in the size of crowds, individual heating and cooling systems are used for each major area in the exposition hall. Altogether, there are 60 separate air-conditioning systems for the 34 million cu ft of air space in the building.

The mechanical center on the lower level of the building consists of two areas: a boiler room and a refrigeration room. Low-pressure steam is supplied to the air-conditioning units for heating, and 42-F chilled water for cooling.

On the floor above, the middle level, is a centralized control room for monitoring the heating, ventilating, and air-conditioning requirements. A 36-ft-long electronic control board contains schematic floor plans which pinpoint the various temperature zones.

Connected with this board are temperature-sensing elements in 140 different locations. The control system automatically mixes warm and cold air so that the proper temperature is maintained in each zone in the building.

Four 600-hp Cleaver-Brooks CB boilers automatically supply steam to meet the varying demands. In addition to heating the building, the boilers are used for heating incoming air, reheating cooled air from the air-conditioning system, and for domestic hot-water needs.

The boilers also switch quickly from gas to No. 6 oil, or vice versa, depending on which fuel is to be used. Natural gas, available at an interruptable rate, is not used when the outside temperature drops below +30 F.

The four-pass design of the fire-tube boilers absorbs all usable heat and has resulted in a fuel-to-steam efficiency of 85 per cent.

The refrigeration room contains three centrifugal plants with 4000 tons of refrigeration capacity. Condensing water is piped from the lake to the refrigeration machines.

John Dolio and Associates of Chicago were the consulting engineers.

800-Mw Turbogenerators

The Tennessee Valley Authority has awarded a contract to the General Electric Company for two 800-mw 3600/1800-rpm steam turbine-generators, believed to be the largest ever ordered.

The first unit, according to the February, 1961, *Power Engineering*, is scheduled to operate in September, 1964, at a location not yet determined. The contract permits cancellation of the order for the second unit at any time up to March 1, 1962.

Although the invitation to bid specified a 2400-psi unit, TVA had the option (until March 1, 1961) of choosing an 1800/1800-rpm unit which would provide a better heat rate but would cost more, or a supercritical-pressure unit for 3500 psi and 3600/1800 rpm.

Total price of the two units is expected to be over $30 million.

There are 60 separate air-conditioning systems in McCormick Place, Chicago's mammoth exhibition hall. These provide individual heating and cooling for each major area to meet the varying load conditions for crowds of up to 30,000.

The DACOM (Datascope Computer Output Microfilmer) eliminates the bottleneck of conventional mechanical print-out. Operating at speeds compatible with the output of most computers, it provides a plain-language microfilm from the information stored on magnetic tape on any background form—bank statement, inventory control, accounts receivable, or similar types of business forms.

Microfilming Computer

RECORDAK CORPORATION, the Eastman Kodak subsidiary in the microfilm and business-system field, will market high-speed computer print-out equipment known as the Recordak DACOM (DAtascope Computer Output Microfilmer). This development links the speed of photographic recording with computer-output speed.

DACOM composes microfilm records from data stored on magnetic tape. It includes:

A magnetic tape drive, which reads computer output tape at 15,000 characters per sec.

A control unit, which decodes the tape data and selects the character to be displayed.

A display unit, which generates the character-forming signals and writes the desired character on a cathode-ray display tube

A camera which automatically records the display on microfilm.

The unit converts impulses carried on magnetic tape to plain language recorded on microfilm at speeds up to 15,000 characters per sec. Eliminating the bottleneck of conventional mechanical print-out, DACOM is in the range of 13 to 130 times faster. Paper facsimile copies can be produced directly from the compact microfilm record at high speed with graphic-arts quality.

Print-out speeds will match computer-output speeds. A complete page of data, containing as many as 8064 characters, can be reproduced in approximately one-half sec in a single 16-mm microfilm frame. Any desired background format, such as a statement, bill, or accounting form, may be optically combined with the output of information, so that the data can be reproduced in final finished form—for example, the print can be a bank statement, ready for mailing to the depositor.

In engineering, where search and retrieval of technical articles and papers are an increasing burden, DACOM has possibilities. In such industries as insurance and public utilities, billing and the recording of customer histories are a possibility. In retailing, the rendering of customer's statements, merchandise control, accounts receivable, and the recording of other large quantities of information become natural applications for DACOM.

Large Turbines

FOUR vertical fixed-blade propeller-type hydraulic turbines, rated 85,000 hp under an 86-ft head at a speed of 120 rpm will be installed by Allis-Chalmers Manufacturing Company, Milwaukee, Wis., in the Susquehanna Power Company's Conowingo hydroelectric station located on the Susquehanna River in Maryland. They will be mounted in plate-steel spiral casings 27 ft 6 in. at the inlet diameter and will be assembled and welded in place at the dam site. They will about double the 252,000-kw capacity of the plant which now has seven Francis-type hydraulic turbines.

The new turbines will produce approximately 60 per cent additional horsepower in the same space as the older ones, because of hydrodynamic advances.

Help Wanted!

OVER 120 new devices and design improvements needed by the Armed Forces are described in a free publication, *Inventions Wanted*, published by the National Inventors Council, U. S. Department of Commerce, Washington 25, D. C.

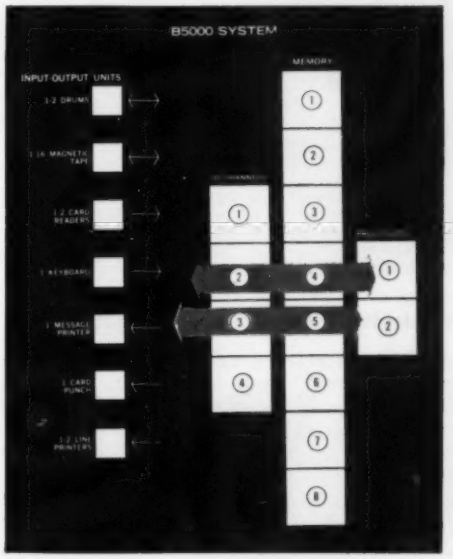
The NIC has served since 1940 as the "open door" in Washington through which civilian inventors may get their inventions to the attention of the Armed Forces and through which the military can inform inventors of defense inventive needs. The Council is composed of distinguished civilian scientists and engineers and the research chiefs of the Army, Navy, and Air Force. C. S. Draper, Fellow ASME, head of the Department of Aeronautics and Astronautics, M.I.T., is chairman.

Some items needed in the mechanical engineering area: (*a*) A strain gage with a 2 to 5-volt output, (*b*) a height-velocity sensor accurate to 0.1 per cent or better, (*c*) a quiet 25-hp hydraulic pump, (*d*) a multipurpose pump weighing less than 1 lb capable of 30 to 40 gpm, (*e*) a quiet high-torque speed reducer able to handle 50 to 1000 hp, (*f*) high-power electric servos, (*g*) a notch-impact test for thin metal sheets, (*h*) a nondestructive test to measure bond strength between similar and dissimilar materials, (*i*) a mechanical bond test for multilayer laminates.

Built on a modular plan, B5000 information-processing systems are available for any size data-processing job. A maximum installation includes two central processors, up to 26 input-output devices, 8 magnetic-core-memory units, and 4 input-output channels. **Right,** Algorithmic-Language and Common-Business-Oriented-Language statements closely resemble their pure derivatives—Algebra and English. The chart, **at bottom,** illustrates the functional interrelation of components in a maximum installation.

mathematical problem:	*data processing problem:*
d=a(b+c)	FICA DEDUCTION = FICA RATE (GROSS PAY+RAISE)
ALGOL statement:	*COBOL statement:*
D:= A x (B+C);	COMPUTE FICA-DED EQUALS FICA-RATE TIMES (GROSS-PAY PLUS RAISE)

B5000 Computer



Burroughs Corporation has announced a new solid-state electronic information-processing system—a self-regulating, problem-oriented, data-processing system that makes flexible multiprocessing (any two or more completely independent programs can be run simultaneously). System expansion without reprogramming is practical for the first time.

Departing from traditional concepts of electronic-computer design, the system—called the B5000—is the first computer designed especially for automatic programming.

A medium-priced system, it will provide large-scale performance for both business and scientific problems.

The piecemeal approach of conventional machines is abandoned and the total problem-solving process attacked—from problem analysis and statement through programming, debugging, and processing to final results.

The computer industry was described as previously engaged in a horsepower race in which computer engineering technology, in providing high internal machine speeds, far outstripped the ability to use this speed efficiently. Every time the speed was increased it became even more difficult to communicate with the computer.

The B5000 is fast (more than 250,000 additions per sec), but this speed is used efficiently.

The problem-oriented system operates in common algebraic and business languages, so that high-speed computations no longer require painfully slow computer programming, problem translation, and debugging.

A complete "software" (automatic programming and operating systems) package—including ALGOL (Algorithmic Language) and COBOL (Common Business-Oriented Language) compilers, as well as powerful extensions of each, and a *comprehensive* master control program—will be standard with each system.

Arresting Jet Transports

A simple and economical airport-runway installation called "Decel" would eliminate overruns and prevent undershooting by commercial-type jets during landing and take-off operations. It has been proposed by the Nortronics Division of Northrop Corporation.

A shallow water-filled basin with a strong, flexible cover would be installed at the windward end of a runway. Jet aircraft that would otherwise overrun the runway roll into the Decel basin. The continual process of depressing the flexible cover and displacing a large volume of water slows the aircraft to a safe stop.

Nortronics has proposed that the Federal Aviation Agency sponsor a full-scale test of the Decel concept which appears to be the most satisfactory of a variety of proposed arresting and energy-absorbing devices.

A preliminary computer analysis of the Decel concept using specifications for the DC-8, 707, and 600-model jet transports has been conducted by Nortronics. Results indicate that at an entry speed of 75 knots a Decel basin 600 to 700 ft long would effectively stop a jet transport without reverse thrust, without brakes, and without damage.

At the Federal Aviation Agency's request, scale-model tests were conducted by the National Aeronautics and Space Administration last March to determine the feasibility of open water and the Nortronics covered-basin method of stopping jet transports. These tests verified the computer analysis and proved the Decel concept superior to the open-water system by stopping a scale-model 707 in shorter distances for the same water depth and entrance speeds.

Not only would the Decel system improve safety of operations but it would save the costs of constructing exceptionally long runways, and in constricted areas it would make possible safe jet operations where none are possible today.

Gas furnishes the electricity, via a thermoelectric generator, to drive the blower in a new gas furnace. Since the power from the generator builds up gradually, the furnace provides a more constant and more uniform air temperature.

Thermoelectric-Powered Gas Furnace

A NEW home-heating gas furnace that drives its own blower with power from a 130-watt thermoelectric generator is being developed by the C. A. Olsen Manufacturing Company, Elyria, Ohio.

Application of thermoelectricity to a gas-fired, forced-air furnace brings a number of significant improvements. Reliability is greatly increased because it doesn't depend upon an external electric power source. Installation costs are lowered since no electrical connections are required, and the built-in power source provides savings in the monthly electricity bill.

Inherent characteristics of the thermoelectric generator make it possible for the new furnace to achieve a more constant and uniform air temperature in the home. When the furnace goes on, power from the generator builds up gradually, starting the blower at a low speed and slowly increasing it. Thus air delivery to the floor registers will increase gradually both in velocity and temperature until the maximum operation of the furnace is attained.

C. A. Olsen Company engineers have been working on this new furnace for more than two years, and the project has now entered the final phase of development. The objective is to produce a central-heating, forced-air furnace with its own source of power using a commercially available blower, while at the same time complying in every respect with the standards set by the American Gas Association.

During recent tests on an experimental unit, the thermoelectric generator produced 130 watts at approximately 9 volts. The heating capacity of the furnace unit is 80,000 Btu.

The thermoelectric generator itself consists of four trays or modules, $8^1/_4$ in. high by $4^1/_4$ in. wide and $2^1/_2$ deep, each containing 47 thermoelectric couples. Spaced at intervals, these modules were installed in openings in the shell of the combustion chamber of the furnace. With this arrangement, the "hot" side of the module becomes an integral part of the combustion chamber. Fins on the opposite side of the module are cooled by the same air that is heated by the furnace and moved through ducts into the rooms of the home.

The basic component of the thermoelectric generator is the thermoelectric couple, which consists of a junction of two dissimilar semiconductor materials. If one side of the couple is heated, raising its temperature above that of the other side, an electric current is generated in the junction.

"Peak Shaving" for Gas

A 120,000-BBL propane storage tank will be used in a giant new refrigerated facility for liquefied gas designed to nearly double the present propane capacity of Minneapolis Gas Company. Scheduled to begin operation in June, 1961, the complete facility will be designed, built, and placed in service by Chicago Bridge and Iron Company.

The Minneapolis Gas plant will be used for "peak shaving"—providing extra gas for customers on days when demand exceeds the natural-gas allotment available by pipeline. It will also serve as a standby source in the event of an interruption in natural-gas-pipeline service. Under the new system, liquid propane will be converted to a gaseous state and injected into the natural-gas distribution system.

The new method is expected to cut unit storage costs on liquid propane about 75 per cent, and will cost substantially less than contracting for additional natural-gas supplies to meet consumer demand on the relatively few winter days it is needed.

Main storage will be in a double-wall tank designed by Chicago Bridge and Iron Company to contain 120,000 bbl of propane at −50 F (equivalent to 137,500 bbl at +60 F). The outer tank will be 106 ft in diam and more than 100 ft high. This outer steel shell—combined with 30 in. of insulating material—will form a vapor-tight barrier to the inner vessel, which will be fabricated of a special code-approved steel.

CB & I will provide refrigeration equipment in two sections: (*a*) "Holding" equipment with sufficient refrigeration capacity to maintain the tank temperature and pressure within the design limits on the hottest day; and (*b*) "filling" equipment capable of holding the tank while receiving 90-F propane at a rate of 120,000 gpd. Both electric motors and internal-combustion engines will be employed as prime movers. Other equipment includes a generator, driven by an internal-combustion engine, with sufficient capacity for "hold" refrigeration and the supply of emergency power.

Normal process control, tank temperature, and pressure will be under constant control of a complete instrument system, which also is designed to meet any emergency. For example, a tankful of propane at −50 F would not reach 1.0 psig for 8 or 9 days, even in the summer, without external refrigeration.

Fully refrigerated storage was selected for the new plant after a thorough study of its merits against those of mined-cavern storage. Lower cost, ease of storage expansion, accurate gaging, consistency, and purity of propane, as well as ease of storage inspection were cited as major reasons for selection of refrigerated storage.

Air-to-Air Heat Pump

A NEW heat pump introduced by the Westinghouse Electric Corporation, Air-Conditioning Division, Staunton, Va., attaches directly to the outside of a wall, greatly reducing the time and cost of installation. Called the WhispAir heat pump, this air-to-air unit is rated at 18,000 Btu per hr ($1^1/_2$ tons of cooling) and 17,000 Btu per hr heating.

Its unique design brings low-cost central-system cooling and mild-weather heating to the mass-housing market. Contractors have placed the cost of the unit, including installation, at approximately $500 for a ranch-style home of concrete-block construction. This cost will vary depending on location, type of construction, and duct-work requirements of the specific installation.

Each unit will serve an area up to 1000 sq ft. For larger homes, two units may be used with one supplying the living-dining area and the other for the bedroom-bathroom area. The heat pump may also be used in multistoried dwellings with one unit serving each floor level. Installation is possible from a balcony, porch, or garage roof. One unique method is to mount the heat pump on a hinged panel similar to a door that is kept closed and locked when the unit is in operation.

The WhispAir heat pump is equipped with twin squirrel-cage blowers, driven by a $^1/_8$-hp motor. These blowers will deliver 650 cfm against a system resistance of 0.2 in. H_2O column. The outside panel of the unit is removable, exposing all major components, providing easy access for maintenance. The embossed aluminum cabinet never needs painting, but can be decorated.

The WhispAir air-to-air heat pump can be installed in residential and commercial structures by removing the equivalent of only two cement blocks

Trackmobile

THE 5-TM Trackmobile is the most recent of a series of versatile vehicles made by the Whiting Corporation, Harvey, Ill., having flanged and rubber-tired wheels.

They can be used on rails to shift freight cars or on their road wheels to draw carts or other portable vehicles for shifting material in and out of a plant or warehouse.

The 5-TM incorporates an Allison torque-converter and hydraulic-transmission combination time-tested and proved in thousands of trucks and off-highway construction vehicles. Together with a 6-cyl 282-cu-in-displacement Hercules they provide finger-tip transmission changes, positive control of movement, full power response, and effective shock-loading protection. The $3^3/_4$-in-bore, $4^1/_4$-in-stroke engine develops 96 bhp at a governed speed of 2500 rpm. Maximum torque is 208 ft-lb at 1500 rpm.

When used as a road vehicle, the Trackmobile is driven forward in a normal manner. In freight-car moving, operation is at right angles to normal. Large cushion tires enable it to cross rails even when they are not countersunk. Once in position athwart the rails, the rubber-tired wheels are hydraulically raised to settle the flanged wheels onto the rails.

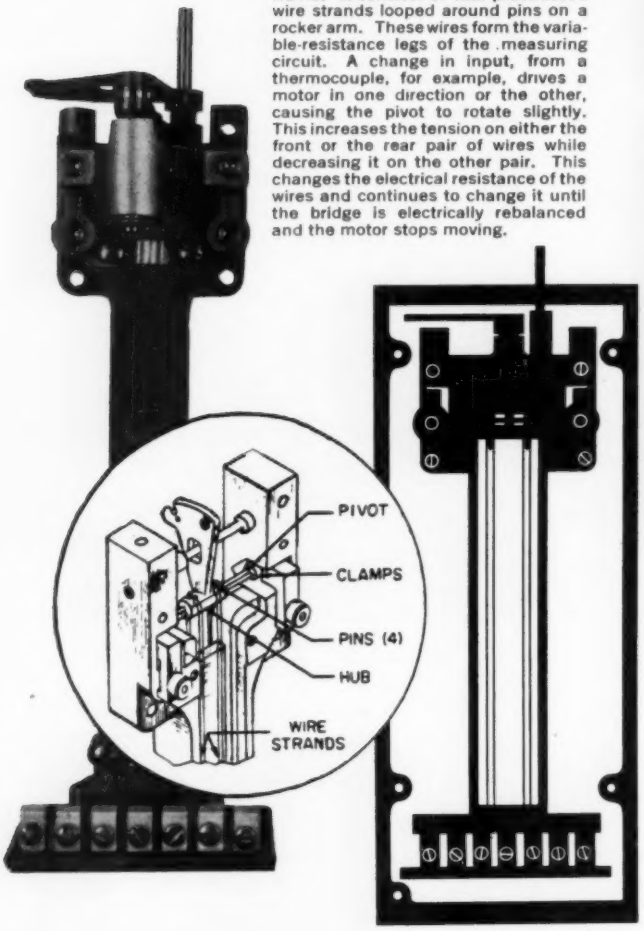
Too light for sufficient traction to move a loaded freight car, it uses a patented hydraulic jacking coupler to transfer part of the car's weight onto the wheels of the Trackmobile. Once it has been "ballasted," it develops 13,000 lb of drawbar pull. On rubber the maximum tractive effort is 3600 lb.

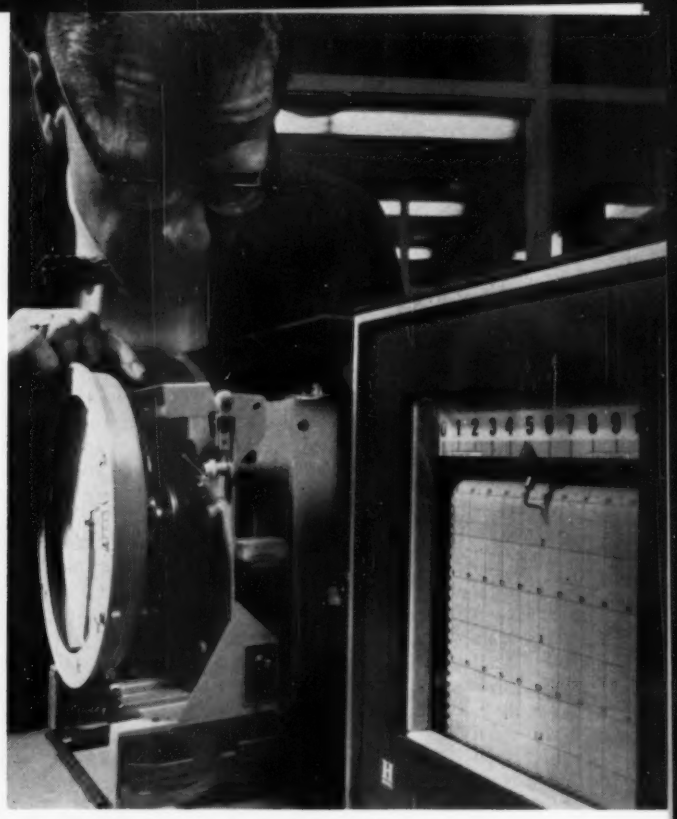
Weighing 11,800 lb with air braking, the maximum speed is 30 mph on rails, 25 mph on rubber.

Used on its rail wheels, the Trackmobile can haul fully loaded freight cars by assuming part of their weight for added traction

Used on its road wheels, the Trackmobile can haul industrial trucks from building to building at up to 25 mph

The Stranducer is an electromechanical strain gage enclosed in an I-shaped frame. It consists of four prestressed wire strands looped around pins on a rocker arm. These wires form the variable-resistance legs of the measuring circuit. A change in input, from a thermocouple, for example, drives a motor in one direction or the other, causing the pivot to rotate slightly. This increases the tension on either the front or the rear pair of wires while decreasing it on the other pair. This changes the electrical resistance of the wires and continues to change it until the bridge is electrically rebalanced and the motor stops moving.





The ElectroniK 17 industrial-process potentiometer replaces the conventional slidewire with an extremely accurate strain gage as the rebalancing element. The motor which varies the tension on the Stranducer wires also moves the recording pen.

Strain-Gage-Rebalancing Potentiometer

A NEW industrial-process potentiometer introduced by Brown Instruments Division of Minneapolis-Honeywell Regulator Company, Philadelphia, Pa., called the ElectroniK 17, incorporates a Stranducer, an extremely accurate, trouble-free electromechanical strain gage, as the rebalancing element. It is expected to open up a new era in precision measurement and recording in industry.

In eliminating the conventional slidewire, long an objective of instrumentation engineers, infinite resolution is achieved for the first time in a potentiometer. No longer is the number of points at which a potentiometer can come to balance limited to the turns (convolutions) on a slidewire.

Initial production of the new potentiometer, which can be mounted in a standard 19-in. relay rack, on a panel or bench, or made portable, will consist of single-pen strip and circular chart recorders and a circular scale indicator, each with or without control. These will be available on an 8-week delivery basis following start of production February 1.

In addition to the Stranducer, the ElectroniK 17 isolates all critical components within an electrical shield, thus rejecting stray signals that cause recording errors and affect the dynamics of the instrument. Stray signals having 60-cycle rms values five times greater than span, and voltage to ground strays of 300 volts d-c or 150 volts a-c will not impair accuracy of the ElectroniK 17.

A single true reference junction compensates for all types of thermocouple actuation.

Transistorized plug-in control units provide up to a maximum of eight set points for auxiliary or zone control. Any combination of these can be supplied as original equipment or be modified as required by the user in his own plant. Compact transistor units control the contact action of single-pole double-throw relays and a single plug-in power supply furnishes input signals to all control-system components.

The all-important Stranducer varies the output potential of the measuring circuit to balance the input signal from the process variable.

Four prestressed looped-wire strands, enclosed in an I-shaped frame, form the variable-resistance legs of the measuring circuit. Their resistance varies in proportion to the tension applied to them.

At zero position, the wires, fastened to the pivot arm of the Stranducer, are in equal tension and are of equal resistance. The pivot arm, as it rocks back and forth, increases tension on two of the wires and decreases it on the other two wires. It is linked mechanically through sector and strap reduction stages and the drive cable to the balancing motor.

The mechanical wear, limited resolution, and "bounce" which occur in slidewire instruments operating at high speeds are eliminated by the Stranducer.

Thermonuclear Progress

"In the early days of the controlled thermonuclear research program, there were many overoptimistic statements about the date of the general availability at competitive costs of power released by fusing hydrogen isotopes. This lies well in the future, if it can be achieved at all." These are the opening statements from a summary of progress on thermonuclear research in recent years, which is part of "Atomic Energy Research in the Life and Physical Sciences, 1960," a special report of the United States Atomic Energy Commission.[1]

Present efforts, the report continues, are devoted to the creation and study of a stably confined plasma that is genuinely thermonuclear, so as to determine the possibility or impossibility of fusion machines producing net power.

High lights of recent progress during the past four years include the following:

In 1956, there was no work on high-energy injection—only preparations for it. In 1960, ions can be injected and trapped copiously at energies far above those required for effective thermonuclear reaction. Here the problem is to increase the confinement time, and with it, the plasma density.

In early 1956, it was not possible to say with certainty that any of the four major laboratories working in this field had produced a plasma with an ionic energy greater than 100 electron volts. Now it appears probable that this energy has been pushed up well beyond 1000 ev, an increase by a factor of more than 10. Energies in the 1000 to 2000-ev range have been achieved at Los Alamos Scientific Laboratory and the Naval Research Laboratory, in relatively dense plasma containing more than 10 million billion ions per cubic centimeter by means of rapid magnetic compression in a mirror geometry. A further increase by a factor of about five would achieve the ideal ignition energy predicted theoretically for the fusion reaction between deuterium and tritium. In addition, the adiabatic-compression mirror device, Toy Top III at Livermore, has produced a stable medium density plasma, containing about 20,000 billion (2×10^{13}) ions per cubic centimeter, in which the ion temperature is about 2800 ev—about half the ideal ignition energy predicted theoretically for the fusion reaction.

There are an additional eight pages of details in layman's terms. Appendix 4, "An Explanatory Statement on Elementary-Particle Physics," is worth its weight in gold to anyone who has tried to understand this rapidly changing area of research.

[1] Price $1.25, Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

Charge Machine for EGCR

A mammoth 480-ton charge machine, which can load and unload uranium fuel in an electrical-power-producing reactor during nuclear operation, has been ordered for the Atomic Energy Commission's 22,300-ekw Experimental Gas-Cooled Reactor, EGCR, in Oak Ridge, Tenn.

It is the first of its kind in the United States designed to perform "on stream" fueling under pressure and high temperature and will operate by remote control.

A subcontract totaling $2.5 million for the charge machine has been awarded to the Baldwin-Lima-Hamilton Corporation of Philadelphia, Pa., by the H. K. Ferguson Company, Cleveland, Ohio, which is the prime construction contractor for the EGCR. Baldwin-Lima-Hamilton will complete the design, fabricate, and deliver the machine in 14 months. Installation will be performed by the Ferguson Company under the supervision of the fabricator's engineers. The basic design and specifications for the charge machine were performed by Kaiser Engineers, Oakland, Calif., who will also check the final design and perform the manufacturing inspection.

By means of a group of tools which are rotated, positioned, and operated by remote control the machine can remove thick radiation-protection fixtures, remove used fuel, install new fuel, and replace the protection fixtures. The machine will be able to store temporarily 12 fuel assemblies within itself during the refueling operation. In addition to its refueling functions, the charge machine will be used to load the initial supply of uranium fuel assemblies to make up the reactor core.

The charge machine will be approximately 43 ft high and 10 ft in diam, and will be mounted on a large bridge crane to permit its being moved into position below the reactor pressure vessel. The operating tools for the charge machine are mounted in a large cylindrical pressure vessel which is heavily shielded. The entire assembly is located in a shielded room directly below the reactor vessel.

Nuclear Briefs

▸German Ship-Reactor Development

A contract for the development and design of an atomic reactor to propel a research ship has been signed by Euratom, GKSS of Hamburg, and Interatom of Bensberg, West Germany. Under the contract, Euratom will finance 40 per cent of the development and design for an organic-moderated and cooled reactor. It is the first all-German project in which Euratom has participated.

Interatom was formed in 1957 by Demag AG of Duisburg and North American Aviation, Inc., through its Atomics International Division, Canoga Park, Calif. Demag is a leading West German designer and manufacturer of heavy machinery. The Gesellschaft für Kernenergieverwertung in Schiffbau und Schiffahrt GmbH (society for the utilization of nuclear energy in shipbuilding and navigation) was founded in 1956 with Germany's big industries taking part in it. The federal government and the four North-German coast states support the society.

▸Uranium Monocarbide, New Nuclear Fuel

Uranium monocarbide, a new fuel for high-temperature nuclear reactors, is available in laboratory quantities from Vitro Corporation of America's, West Orange, N. J., laboratory.

Available as granules or as 200-mesh to $^5/_{16}$-in-diam high-density spheres, UC is attracting considerable attention because it combines high thermal conductivity, melting point, and uranium density with an excellent irradiation stability.

Materials Briefs

▸Plastics for Gas-Turbine-Compressor Housing

A GAS-TURBINE-COMPRESSOR housing has been fabricated of glass-reinforced phenolics and polyesters rather than the traditional magnesium alloys. The development was disclosed in a Westinghouse Electric Corporation Materials Laboratory paper presented at a Society of Plastics Engineers Technical Conference held in Washington, D. C.

This structural application in jet engines suggests an entirely new area of application for plastics, providing lightweight and corrosion resistance. Estimates indicate that cost of plastics housings are on the order of one half that of conventional metals, primarily because of the drastically reduced machining that is required in finishing them.

Performance of the plastics-housed turbine was substantially improved due to reduced expansion of the plastics and correspondingly reduced clearances between blade tips and housing. As a result of this decreased thermal expansion it is possible to maintain higher air pressures which in turn result in greater turbine efficiency.

▸Modified Polybutadiene Has Excellent Abrasion Resistance

A new modified polybutadiene polymer, Hycar 1000×145, with excellent abrasion resistance that does not become brittle even at −85 F is being manufactured by B. F. Goodrich Chemical Company, Akron, Ohio. It also has moderate resistance to the effects of fuels, solvents, and chemicals, excellent electrical properties, and ozone resistance, making it an ideal material for use in the electrical wire and cable field. Other applications include machine parts, where abrasion resistance is important, and hose coverings.

▸Improved Vinyl-Chloride Polymers

Four new and improved vinyl-chloride polymers with a broad range of balanced properties have been introduced by Monsanto Chemical Company's Plastics Division, Springfield, Mass. Opalon 440 is a new plastisol resin with excellent clarity and stability; the other three are the first of a new Opalon 600 series of suspension resins, with improved heat stability, color, and processability, when used in such techniques as extrusion, molding, and calendering.

The Opalon 600 series has electrical properties that meet UL specifications, in addition to excellent over-all physical characteristics. Opalon 600 has a specific viscosity of 0.55, Opalon 650 of 0.48, and Opalon 630 of 0.39. All have excellent dry-blending characteristics and combine outstanding color, clarity, and long-term heat stability with very fast processing at high quality.

▸Fluxless Solder for Aluminum and Other Metals

Another entry in the parade of fluxless solders has been introduced under license by Metals for Industry, Inc., Jersey City, N. J. Called Tin-A-Lum, it melts at 410 F, can be applied to aluminum and its alloys, tin, tin-plate, copper, brass, galvanized iron, die-cast alloys, magnesium, and other metals. A soldering iron or a light flame is sufficient although both surfaces must be tinned first and then sweated together for a joining operation.

In four United States Testing Company, Inc., tests breaking load for butt-lapped specimens ranged from 462 to 546 lb, shear stress on the joint was 906 to 1020 psi, ultimate stress 11,270 to 13,000 psi. Corrosion tests in compliance with ASTM B537-57T by another laboratory showed less corrosion on a soldered lap joint than on the original aluminum metal after 48-hr exposure to a spray of 5 per cent NaCl.

Guyed Aluminum Towers

THE American Electric Power System plans to construct four major transmission lines utilizing guyed towers made of aluminum.

The four 138,000-volt lines will total 100 miles.

Two will be built from the Smith Mountain hydroelectric project of Appalachian Power Company, on the Roanoke River 46 miles southeast of Roanoke. The other two lines will begin at the Big Sandy Plant of Kentucky Power Company at Louisa, Ky.

Michael Flynn Manufacturing Company, Philadelphia, Pa., will fabricate the towers.

The V-shaped structure with a single compression foundation and four guy wires for support is similar to designs used in Finland and Sweden which rely entirely on stranded guy wires for support. AEP's design was recently developed by Aluminum Company of Canada on one of its own 345,000-volt lines in eastern Canada.

Mechanics of Adhesive Bonding

THE analytical and practical aspects, the structural applications, and some of the current problems of adhesive bonding are the subject of a generously documented article by N. K. Benson, head of structures laboratory, CIBA (A.R.L.) Limited, Duxford, Cambridge, England, in the February, 1961, *Applied Mechanics Reviews*.

Noting that "practically any solid substance may be stuck to another with some degree of success," the author confines the paper to high-strength adhesive joints and those where the bond is essential to structural efficiency by virtue of its stabilizing attachment.

The analytical section deals with lap joints in tension; scarf, butt, and tubular joints; lap joints in edgewise shear; as well as internal stresses and peeling.

The commonly used types of materials are classified in a discussion of the practical aspects of adhesive bonding.

There is an explanation of "peel strength" and an evaluation of "peel tests." The author stresses the need for better understanding of the mechanism of adhesion and of the physical properties of the adhesives themselves.

Metal-Composite Seal Rings

A NEW composite of two metals has been developed for use in high-temperature, high-pressure static seals up to 1200 F and 5000 psi by Armour Research Foundation, Chicago, Ill.

The composites, developed for Materials Central, Wright Air Development Division, U. S. Air Force, are made by impregnating a porous body of fiber metal (or

skeleton) with a soft metal. The resiliency of the fiber-metal skeleton combines with the softness and conformability of the impregnant to offer a seal material for almost any static high-temperature high-pressure purpose. In addition, the metals are corrosion-resistant for use with chemicals, exotic fuels, or hydraulic fluids.

The fiber-metal skeletons, usually of molybdenum or stainless steel, are made by felting metal fibers, compressing them and then sintering to form a bond between the fibers at each point of contact.

The skeletons can be made as dense as desired and, therefore, tailored to meet different seal needs. They can be machined to desired shapes and configurations by temporarily impregnating them with salt.

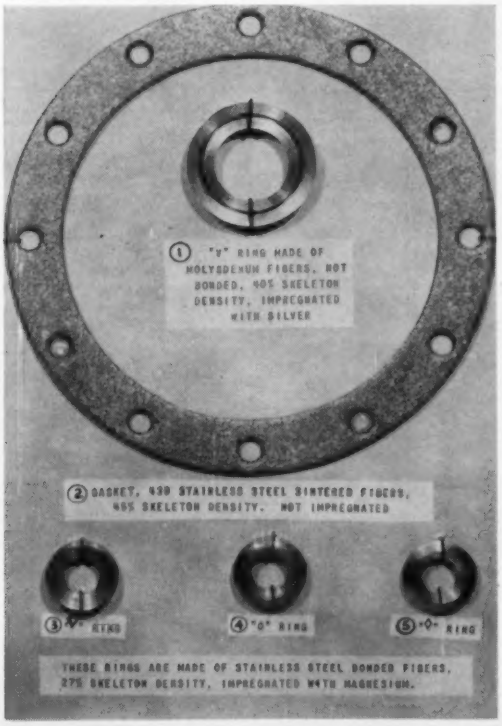
Generally speaking, the higher the melting temperature of the metal filler, the higher the temperature a seal will withstand. When the fiber-metal skeleton is impregnated with the filler, the material literally becomes a sponge within a sponge. Since both metal networks are continuous, this sponge-within-a-sponge idea offers an optimum situation for realizing the combined properties of each.

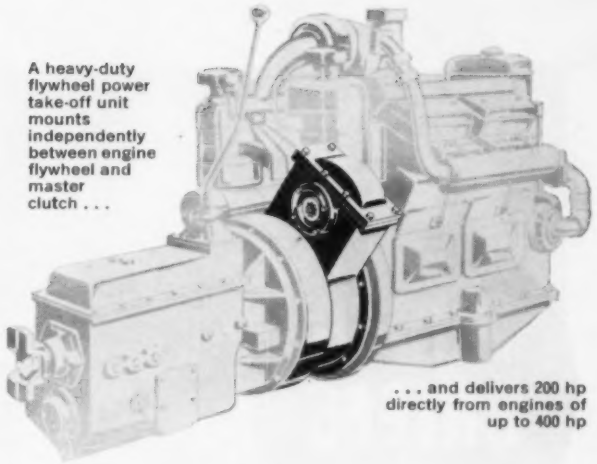
Experimentation has shown that a composite made of a molybdenum-fiber skeleton and impregnated with silver retained hot-air pulsating pressures from zero to 5000 psi at 1200 F. In other evaluations, the same composite material was subjected to temperatures cycled from about 72 to 1000 F with the same pulsating gas pressures from 0 to 5000 psi applied at both temperature extremes. After three such temperature cycles, no trace of leakage and no loss of bolt torque was detected.

Tests performed by Republic Aviation indicate excellent static-sealing results with the molybdenum-silver composite. Hydraulic fluids were retained for a total of 93 hr in the tests and 336,984 impulse cycles at 1000 F without signs of leakage. This included repeated assembly and disassembly and 12 thermal cycles.

Use of a composite material in dynamic-seal applications is in the experimental phase. Polymeric materials are being used as impregnants for the fiber-metal skeletons with good preliminary results.

High-pressure static seals are made of a composite of two metals by impregnating a porous body (or skeleton) of fiber metal with a soft metal.





A heavy-duty flywheel power take-off unit mounts independently between engine flywheel and master clutch . . .

. . . and delivers 200 hp directly from engines of up to 400 hp

Power-Take-Off Unit

A FLYWHEEL power-take-off unit which can deliver 200 hp directly from engines rated up to 400 hp eliminates costs of auxiliary engines and "service-heavy" shafts for many power-take-off configurations.

The heavy-duty flywheel PTO, designed by Cotta Transmission Company, Rockford, Ill., mounts independently between engine flywheel and master clutch. Power can be taken off when the clutch is disengaged.

In addition to saving initial and maintenance costs of intricate power-take-off designs, Cotta's "spacer" PTO increases versatility of heavy construction equipment, airport utility vehicles, fire trucks, generators, auxiliary hydraulic equipment, air compressors, drills, and similar equipment. The compact unit adds only $12\frac{1}{4}$ in. to power-train length.

Simple installation adapts this flywheel PTO to any gasoline or diesel engine. No alterations are required for other power-train components. Standard mounting, front and rear, is provided by either SAE No. 1 or No. 2 housing. Housing cast as one unit endures heavy shock loads.

The speed ratio of the standard model is 1.24:1. Rotation at 30-deg increments positions the unit for specific jobs.

A straight-through shaft transmits the engine power to the master clutch and transmission. Three helical gears deliver power from the main shaft to the power-take-off output shaft.

Cotta Transmission Company customizes standard transmissions to individual heavy-duty applications requiring input torques from 150 to 2500 ft-lb.

Plasma-Jet Test Stand

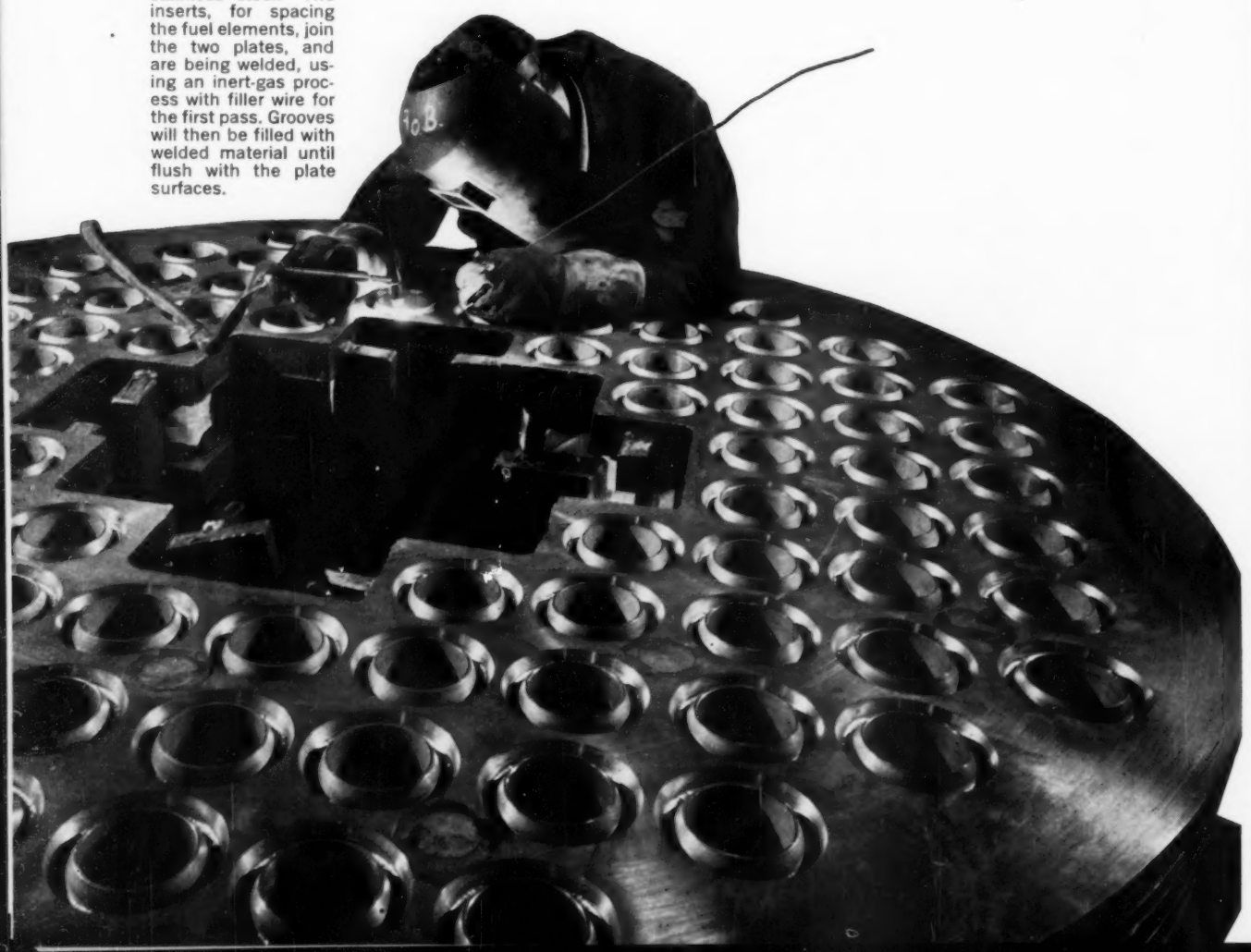
A CONTRACT has been awarded to Allis-Chalmers Manufacturing Company, Milwaukee, Wis., for the design and construction of a 1-mw plasma-jet test-stand facility at the Los Angeles Division plant of North American Aviation, Inc., in El Segundo, Calif.

The new facility will generate plasma by electrically heating the gas causing it to ionize. This plasma will then be accelerated to hypersonic velocity through a convergent-divergent nozzle. The resulting ultrahigh-velocity, high-temperature plasma stream will be directed through a test chamber in which exotic material will be tested for thermal shock resistance and aerodynamic reactions.

PHOTO BRIEFS

M. BARRANGON

Reactor Grid Plate. A grid plate for Northern States Power Company's plant near Sioux Falls, S. D. From Allis-Chalmers comes this view of the $6^1/_2$-ft-diam built-up disk, a sandwich of $2^1/_2$-in-thick top and bottom plates with a 4-in spacer ring at the periphery — all of stainless steel. The inserts, for spacing the fuel elements, join the two plates, and are being welded, using an inert-gas process with filler wire for the first pass. Grooves will then be filled with welded material until flush with the plate surfaces.

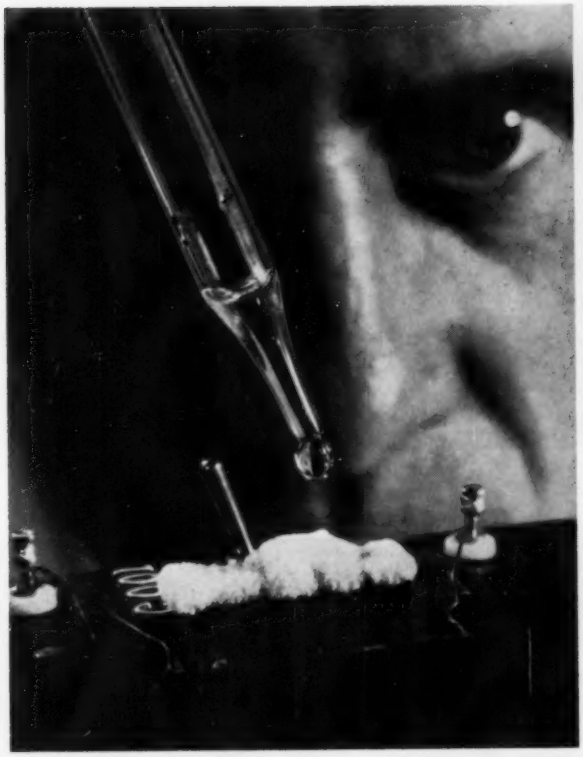


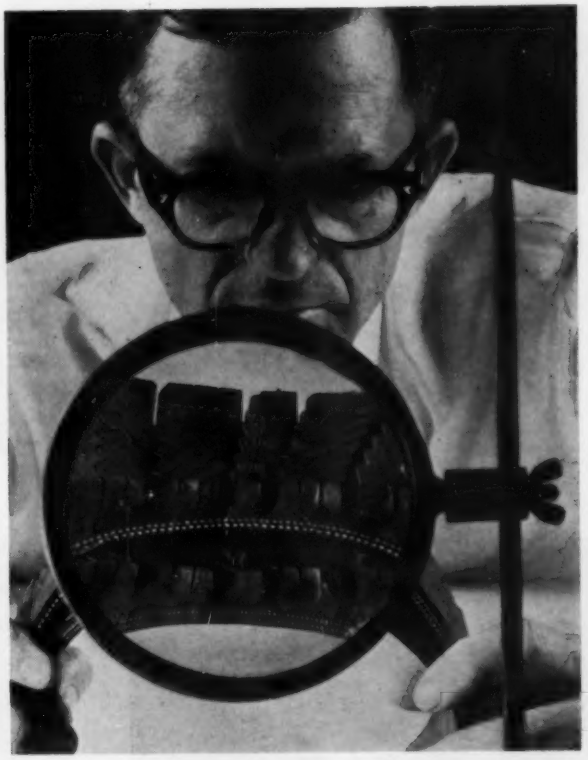
Heater-Freezer. Power from two flashlight batteries can freeze water by means of this thermoelectric device developed at Hughes Aircraft. Reverse the current, and the device becomes a heater: In a few seconds the ice disappears in a wisp of steam. This is thermoelectric cooling, but with a new technique of fabricating the thermoelectric material, so that current needed is $^1/_{10}$th that previously required.

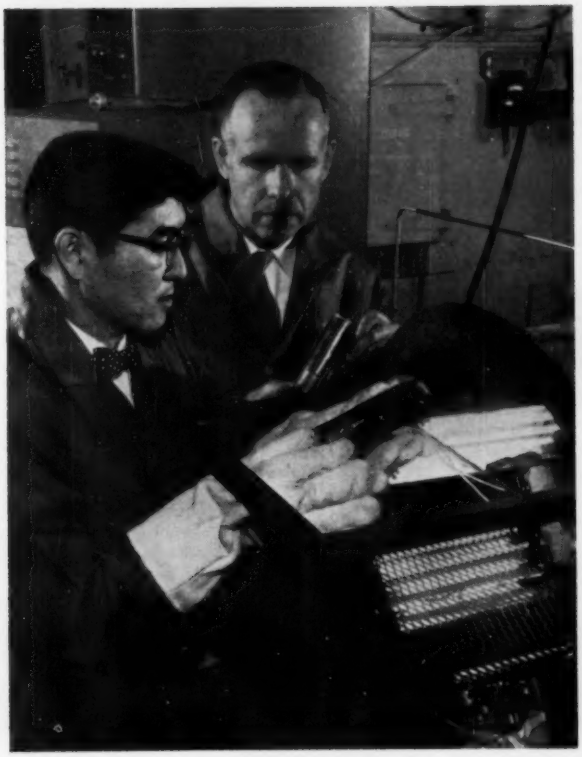
High - Temperature Motor. That's a tiny electric motor going into an oven where it will be tested at 600 F, hot enough to melt the tires off an automobile. It's designed for the electrical throttle-control system of the 2000-mph B-70 bomber. Motor and control system were developed by North American's Los Angeles Division. The motor, with stainless-steel frame and ceramic-encapsulated wire, must be able to operate in a range from +550 F to −65 F.

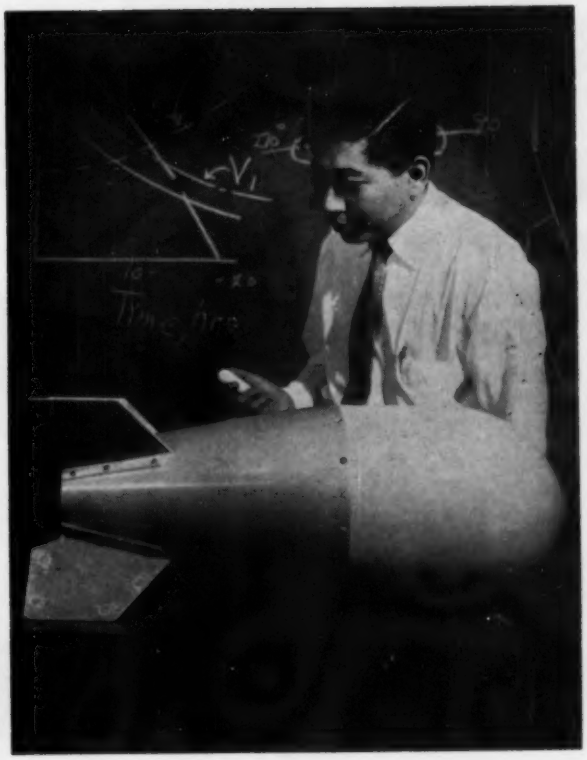
Tire for Compacts. At B. F. Goodrich Company, Akron, Ohio, a two-ply tire for small cars has been developed. The new tire **(top),** lighter in weight, softer riding, cooler running, has thinner side walls, but all the strength and endurance of the four-ply tire **(bottom).** Cords are larger, and pack more strength in fewer strands. A "pilot quantity" of the new tires is in the hands of automobile manufacturers for testing.

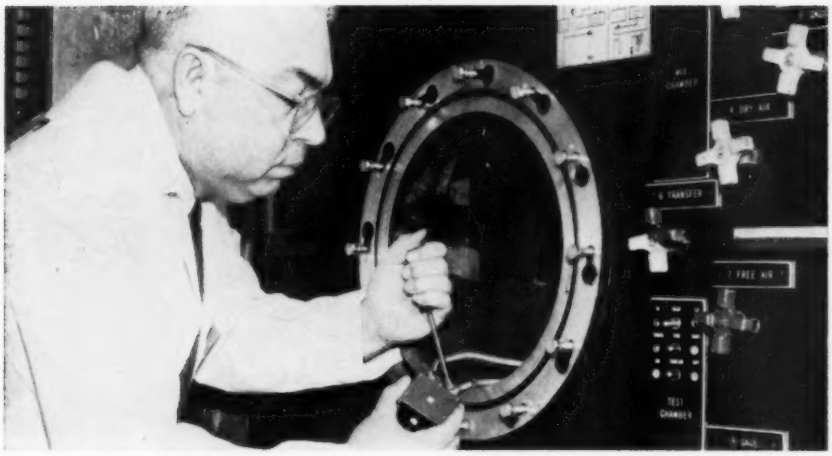
Davy Crockett. Nose cones and tail fins for the Army's Davy Crockett projectile are made at the Plastics Plant of Raytheon Company's Aero/Weapons Division, Maynard, Mass. Molded from a plastics compound by compression techniques, the cone serves as a ballistic windshield. Fins have high structural values for rough handling and for true flight. The projectile gives infantry and armored troops a low-yield nuclear punch at close range.





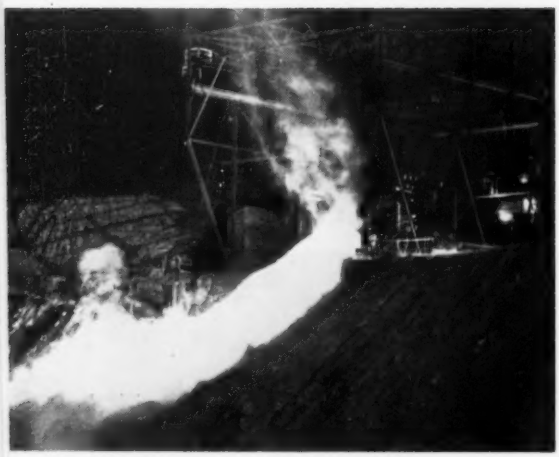






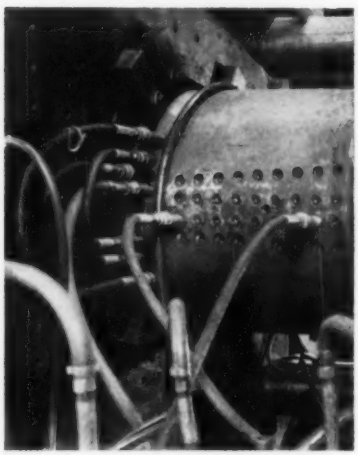
◀ **Explosion Chamber.** Will the electrical device cause an explosion? At Boeing, Wichita, Kan., small switches, circuit breakers, and motors for the B-52H missile launcher undergo tests in this explosion chamber. With parts inside and functioning, an explosive mixture is fed in. If the mixture explodes, the parts—and all like them—are rejected.

Air Gages. At Allis-Chal- ▶ mers, West Allis, Wis., this battery of air gages serves as a precision inspection tool for large turbine blades. A blade is inserted in the holding fixture at the **left.** When the two gates are closed, 25 readings are obtained simultaneously, checking the blade for alignment, form, and size.



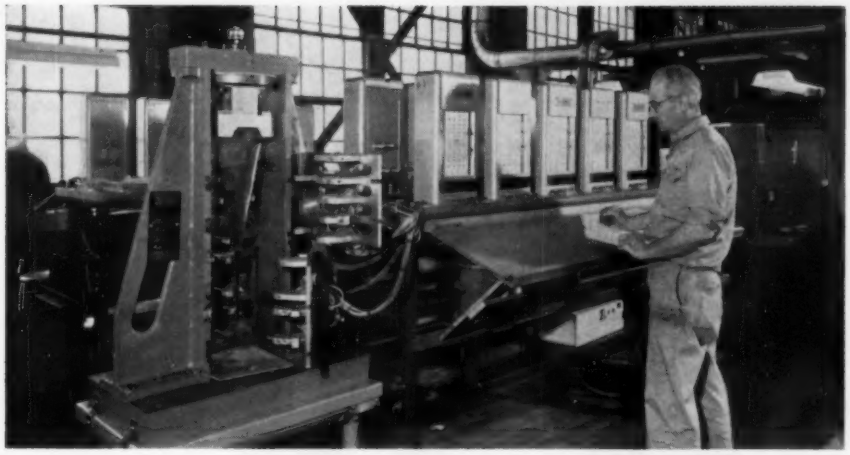
◀ **Mighty Thrust.** More than a million lb of thrust is back of that flame roaring over the desert at Edwards Rocket Base, coming from a prototype thrust nozzle for the F-1 rocket engine. A complete engine will be tested later this year. Rocketdyne, a division of North American Aviation, is developing the F-1.

Injection Molding Machine. ▶ An injection molding machine turns out a plastic utility basket at the plant of Loma Industries, Inc., Fort Worth, Texas. Water, from condensation in the hydraulic oil, rusted pump valves. The problem was overcome when Gulf Oil produced an oil with superior water-separating and lubricating properties.



◀ **Weather Plotter.** A computer-plotter, developed by Electronic Associates, Inc., Long Branch, N.J., produces weather maps in less than three min. The plotter, at the Weather Bureau's National Meteorological Center, Suitland, Md., accepts forecast information on magnetic tape; the "mechanical hand" draws contours or isobars.

Maxsecom. Maximum se- ▶ curity communications. Words spoken into this device are electronically converted into infrared beams and transmitted to a receiver, which converts back into sound. Aeronautical Division of Minneapolis-Honeywell developed the "ray gun" for secrecy and immunity to jamming.



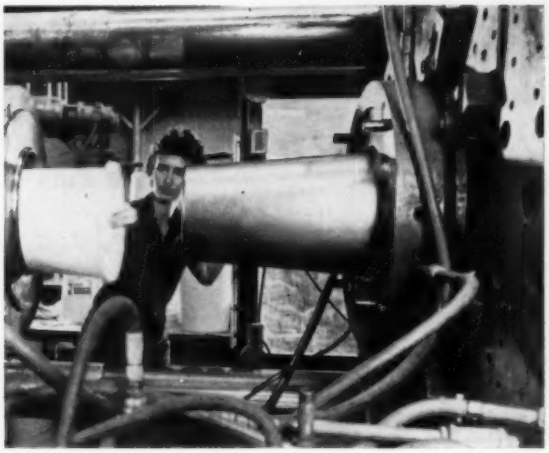
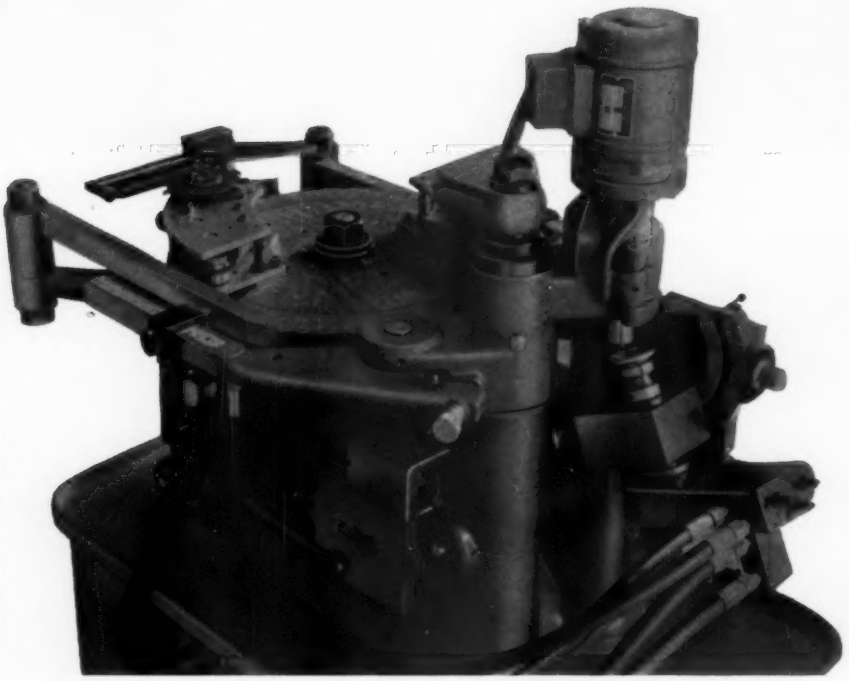


PHOTO BRIEFS

Engineering Progress in the British Isles and Western Europe

J. FOSTER PETREE
European Correspondent

EUROPEAN SURVEY

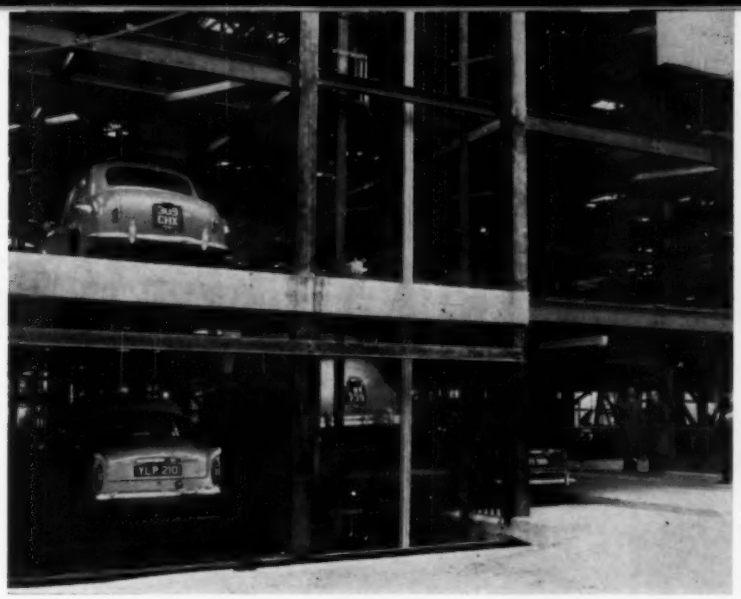


Automatic engraving and marking machine has inclinable indexing unit for numbering objective rings and similar parts. It can be fitted with an automatic feeding device. It also will cut scales and engrave on cylindrical parts.

Automatic Engraving and Marking Machine

In the production of many types of quantity-manufactured instruments and apparatus (for example, cameras) the neat and accurate engraving of numbers, scales, and setting marks is of great importance to the appearance and functioning of the completed article. A machine for effecting this engraving automatically and in any desired quantity has been developed by a Swiss firm, Machines Universelles Billeter and Co., 4b Rue de Corcelles, Peseux (Neuchâtel). It can be set to engrave the same number, such as that of a patent, on any quantity of similar parts, or a consecutive series of numbers. In either case the operation is entirely automatic. The motion is controlled by a set of large cams, with lever arms in contact with the cams actuating the workpiece and the cutter. Two flat cams control the horizontal motion, and a third cam, which is bell-shaped and fitted onto the lower flat cam, controls cutting depths. The machine has an inclinable indexing unit for the numbering of objective rings and similar parts. The tilting mechanism is hydraulically driven, and hydraulic pressure is also used to actuate the clamp that holds the workpiece.

The machine can be fitted with an automatic feeding device consisting of a hopper, into which parts can be loaded in bulk; a vibrator; a pneumatically operated feeding lever; and means for ejecting the finished component from the clamp. Another attachment provides for engraving on cylindrical parts. Scales can also be cut, the number of strokes composing the scale and the spacing of the strokes being controlled by electromagnetic couplings. Two identical scales with different lengths of stroke can be engraved with the same set of cams. A device is available also for the proportional reduction of letter sizes, using only the one set of cams. The ratio of reduction is adjustable at will by locking in appropriate positions two keys mounted on slides. The surface that can be machined at one setting is 72 mm by 48 mm; and the guaranteed accuracy, when machining to prints or sample parts, is within ±0.01 mm (0.0004 in.). This accuracy can be doubled, to ±0.005 mm (0.0002 in.), when working to measuring gages. Other models are also made, and with suitable additional equipment the same machines can be used for precision milling, beveling, contour milling of recesses, drilling and countersinking blind or clear holes, and in some instances the cutting of small pinions and gears.



Several levels of Zidpark viewed from above, **right,** show cars as they will appear while parked. The Zidpark will accommodate 464 cars.

Britain's first fully automatic, multi-story car park, the Zidpark, **left,** undergoes tests during construction at Southwark Bridge, London. Sixteen elevators will hoist cars from street level to eight floors.

Push-Button Parking

In a new building under construction near Southwark Bridge, London, England, tests have been carried out recently of a system of off-the-road car parking which, it is claimed, will be able to receive cars off the street at the rate of 250 in half an hour. It is called the Zidpark and is the invention of a French engineer, Mons. Andre Thaon, now living in Switzerland. The British rights have been acquired by Myton Ltd., one of the firms in the Taylor Woodrow group of building and civil-engineering contractors. The Zidpark will accommodate 464 cars on eight floors. Sixteen elevators hoist the cars up from street level, and at each floor they are moved sideways on conveyers. Each car berth has two synchronized conveyers for the front and rear wheels, respectively.

The transport of each individual automobile from street level to its parking place, and its subsequent return to street level, are entirely automatic, neither the driver nor an attendant going up with it; all movements are directed from a control panel at ground-floor level. The park is divided into 16 sections, each with its own elevator, serving four spaces on each of the floor levels. The layout of the controls corresponds to that of the parking berths, each of which is represented by a numbered plug inserted on the control board as a space is selected.

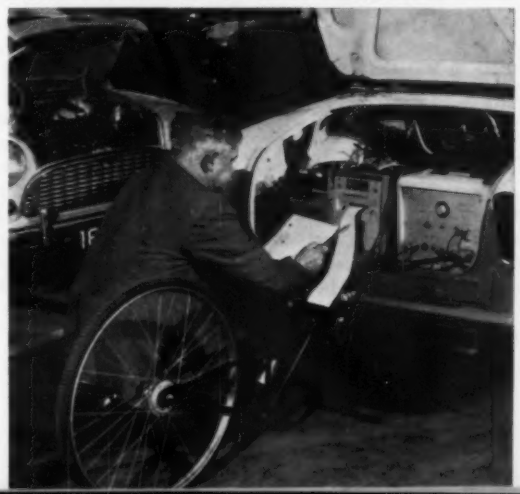
On arrival, an automobile is directed onto one of the conveyers adjoining the elevators, the engine is stopped, and the brakes applied. The driver then leaves it after receiving a numbered counter corresponding to the numbered plug selected by the operator. The operator inserts the plug into the control panel, and the car is then taken automatically to the appropriate berth. The reverse process brings the car out again and down to street level. One vacant space is left on each floor to permit shunting of cars so that one placed in an inner position can be brought readily to the elevator.

Measuring Vehicle Acceleration

Apparatus that will record changes in the acceleration of a motor vehicle on the road within a thousandth of a second has been developed by the Research Center of Shell Research, Ltd., at Thornton, Cheshire, England, where it is used to compare the performances obtainable with different kinds of motor fuels. It can measure the acceleration of the vehicle itself or the acceleration of the engine, which are not necessarily the same. The drive is obtained from a bicycle wheel mounted in a sprung frame attached to the rear bumper of the vehicle. The time for each revolution of this wheel is automatically recorded on a paper tape. When it is desired to record the acceleration of the engine, the accelerometer is connected electrically to the contact-breaker of the car's distributor. The tape then records the time in milliseconds for each revolution of the engine. In both cases a running record is simultaneously printed of the time elapsed since the acceleration began.

Correspondence with Mr. Petree should be addressed to 36 Mayfield Road, Sutton, Surrey, England.

A highly sensitive device for measuring the acceleration of cars on the road is checked. The device measures and records on tape the time for each revolution of the bicycle wheel.



Substance in Brief of Papers Presented at ASME Meetings

ASME TECHNICAL DIGEST

Production Engineering

The Effects of Electrolytic Assistance in Peripheral Grinding..60—WA-4... By W. R. Backer and R. A. Dahlin, Assoc. Mems. ASME, Norton Company, Worcester, Mass. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

Electrolytically assisted grinding is accomplished by passing direct electric current from the workpiece to the grinding wheel through an ionized fluid, while the abrasive in the wheel is simultaneously removing metal mechanically.

Plunge-surface-grinding with simultaneous electrolytic deplating of the workpiece was investigated. A relationship was found between the electrolytic current density and the chip geometry, supporting the use of very low work speeds and large depths of cut. The relative amount of metal deplated depended primarily on the work material. The reliability of Faraday's law in predicting performance was also a function of the work material, probably because of the particular reactions with the electrolyte. A hydrodynamic force was encountered due to the use of a metal-bonded wheel.

It is hoped that future work on such wheels, with wheel-wear data, will be undertaken to further the knowledge of electrolytically assisted grinding. The results also suggest an advantage for higher wheel speed that is worthy of investigation.

Shear in Metal Cutting..60—WA-80... By Fenton L. Bagley, Jr., Assoc. Mem. ASME, Pittsburgh Plate Glass Company, Pittsburgh, Pa. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

This is a theoretical discussion of the various shearing phenomena observed in metal cutting. As an introduction, the process of continuous, homogeneous chip formation is briefly discussed. The shear process producing the continuous and discontinuous segmented chip is discussed from various points of view. An explanation of the variation of the shear angle with cutting speed is proposed in view of current high-speed machining data. The effects of these shear phenomena upon the metal-cutting process at high speeds are discussed with respect to feasibility for production usage. Recommendations for further work are presented.

Milling Forces Measured With a Planetary-Gear Torquemeter..60—WA-3... By J. R. Roubik, Assoc. Mem. ASME, Kearney and Trecker Corporation, Milwaukee, Wis. 1960 ASME Winter Annual Meeting paper (multilithographed; to be published in **Trans ASME—J. Engng. for Indus.**; available to Oct. 1, 1961).

Because of its relative simplicity, turning is generally resorted to for cutting-force measurements with dynamometers. If due consideration is given to the similarities and differences between turning and milling, data obtained in turning tests may, for approximations, be applied to milling situations. In order to obtain more direct information on the behavior of milling forces, a planetary-gear dynamometer was designed and built.

Cutting-force data, obtained with the torquemeter in carbide-milling tests on SAE-1018 cold-rolled steel at feeds from 0.002 to 0.030 in. per tooth, cutting speeds from 87 to 957 fpm, and depths of cut from 0.100 to 0.300 in. with a tool geometry of −7, 0, 3, 5, 0, 15 deg, $^1/_8$ in. × 45 deg are presented.

The influences of variations in cutting speed, feed per tooth, and depth of cut on tangential cutting force are depicted graphically. Cutting-force values for other workpiece materials are also included. With these data a comparative method of experimentally verifying the computed high efficiency of the torquemeter itself is derived and applied. A method of obtaining highly accurate determinations of milling-machine efficiency under actual oscillatory cutting loads is described with an example. Actual and theoretical traces of the variation of tangential cutting force with both single and multiple-toothed face milling cutters are illustrated for comparison.

Fundamental Machinability Research in Japan..60—WA-78... By Katsundo Hitomi, Kyoto University, Kyoto, Japan. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.**; available to Oct. 1, 1961).

Machinability research in Japan has been affected by development of metal-cutting theory and manufacturing technique in foreign countries, especially the United States and Germany.

Research work in this area started about thirty years ago when Professor Okoshi, Tokyo University, presented the first report on fundamental study on cutting action and type of chip. Since then much fundamental and also practical work has been done to develop Japanese manufacturing processes. Reports have been presented in the fields of mechanics of orthogonal cutting and three-dimensional cutting, cutting temperature, tool life test, wear process of carbide and ceramic tools, surface roughness, chip control, cutting fluid, chatter, hot machining, cold machining, drilling, milling, and others. In addition to regular cutting operations, fine finishing techniques such as grinding, polishing, lapping, superfinishing, ultrasonic machining, electrodischarge machining, have been investigated and developed.

Among these subjects in this paper, the author will discuss topics such as fundamental analyses of mechanics of orthogonal cutting, cutting temperature, tool wear process, development of ceramic tooling, chatter, surface roughness, and

Maintenance welders at the plutonium production plant, Hanford Works, often must don cumbersome equipment, **right,** or squeeze into small areas, **left** (60—WA-244)

two special topics investigated and developed recently in Japan—the ultrasonic cutting method and the silver-white chip cutting method.

An Analysis of the Mechanism of Orthogonal Cutting and Its Application to Discontinuous Chip Formation..60—WA-79... By Keiji Okushima and Katsundo Hitomi, Kyoto University, Kyoto, Japan. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.;** available to Oct. 1, 1961).

Instead of the conventional theory of the mechanics of metal cutting based on a process of shear confined to a single shear plane, the concept of flow region, a fairly large transitional deformation zone which exists between the rigid region of work and the plastic region of steady chip, was developed. The mechanics of orthogonal cutting were analyzed, theoretical equations for angles of boundary lines of the flow region and for strain in chip were deduced in the case of simple continuous chip formation and confirmed in cutting tests on lead. The concept of flow region was also applied to discontinuous chip formation, and theoretical expressions for angles of boundary lines of the flow region were ascertained to be in agreement with the experimental result for carbon steel.

Analysis and experimental results lead to the following conclusions.

1 The expressions for angles of the boundary lines of the flow region were deduced theoretically in the case of the simple continuous chip under the assumption of a perfectly plastic solid and confirmed in cutting tests with lead.

2 Conflicts in the cutting mechanism based on the single shear plane, such as an abrupt change of movement of a metal particle, an infinite acceleration which a metal particle receives, extremely large strain and strain rate, etc., can be removed by the flow region concept.

3 The flow region concept was applied to discontinuous chip formation. Considering the strain-hardening property of metal, equations for angles of the starting boundary line and the end boundary line (fracture line) of the flow region were deduced theoretically, and determined to be in agreement with the experimental result for carbon steel.

Maintaining High Levels of Weld Quality in a Plutonium Production Plant.. 60—WA-244... By C. D. Brons, General Electric Company, Richland, Wash. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

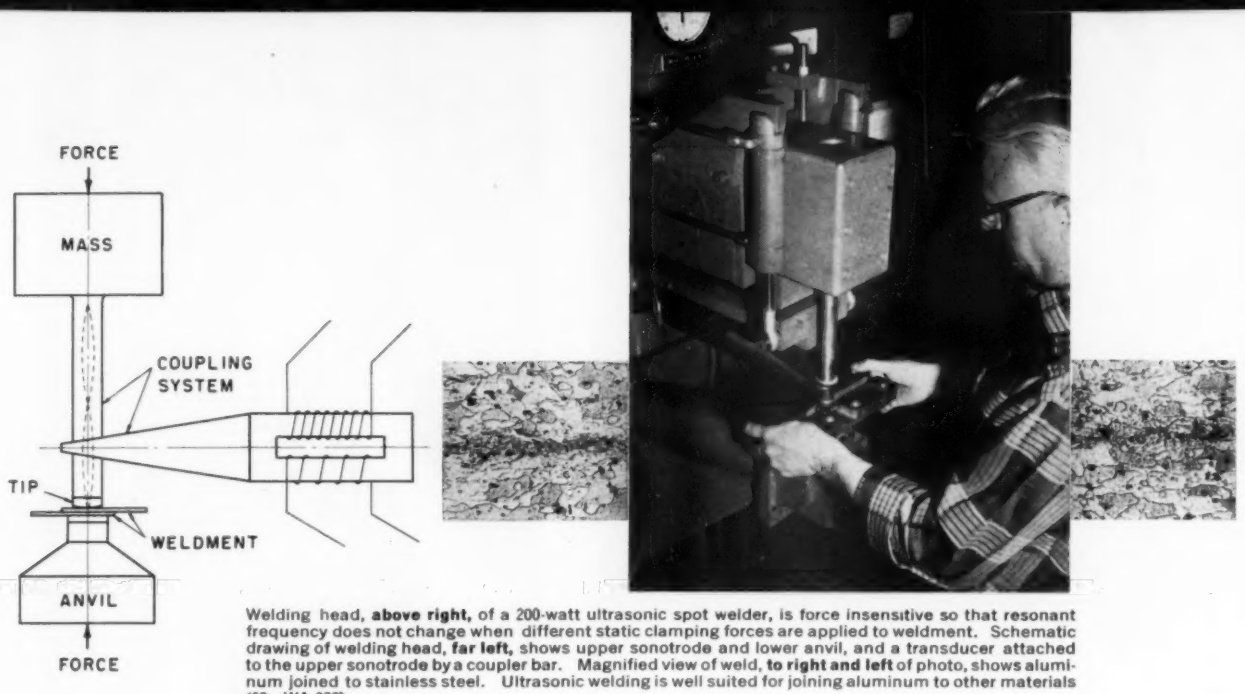
In establishing a weld quality-control program, one of the first factors to be considered is to determine what is acceptable, quality-wise, for the various services to which weldments are to be subjected. In a plant such as Hanford more distinct kinds of operating service are dealt with than will be found in any other industrial operation.

Maintenance welding personnel are concerned with the more common plant maintenance problems such as the repair of shop equipment, the maintenance, repair, and alteration of water lines, steam distribution systems, air-conditioning equipment, and so on. Maintenance welding must also be done in radio-chemical processing plants where highly corrosive solutions are handled, and in and around the Hanford reactors where service conditions require the highest weld quality attainable. In some areas of the plant it is not possible to make repairs, owing to contamination or radiation, and even where fabrications which have failed can be removed from contaminated areas by remote control, the cost of decontamination would be prohibitive even if it were possible. For these reasons it is mandatory that replacement parts or equipment being placed in these areas must be as near as possible to the ultimate in quality.

The welding program to alter, improve, and maintain the Hanford reactors and radio-chemical processing plants is outlined.

Forces on a Worn Cutting Tool..60—WA-86... By H. T. McAdams and Paul Rosenthal, Assoc. Mem. ASME, Cornell Aeronautical Laboratory, Inc., Buffalo, N. Y. 1960 ASME Winter Annual Meeting paper (multilithographed; to be published in **Trans. ASME—J. Engng. for Indus.;** available to Oct. 1, 1961).

A cutting tool exhibits at least two types of wear; namely, crater wear and flank wear. Because of its predominant importance in most applications, flank wear is a widely used criterion for evaluating tool life.



Welding head, **above right,** of a 200-watt ultrasonic spot welder, is force insensitive so that resonant frequency does not change when different static clamping forces are applied to weldment. Schematic drawing of welding head, **far left,** shows upper sonotrode and lower anvil, and a transducer attached to the upper sonotrode by a coupler bar. Magnified view of weld, **to right and left** of photo, shows aluminum joined to stainless steel. Ultrasonic welding is well suited for joining aluminum to other materials (60—WA-322).

The forces on a single-point cutting tool under conditions of progressive flank wear are analyzed under the assumptions of constant rake, friction, and shear angle. Relations between wear-land area and stock-removal rate are derived for the case of constant feed force. For the case of constant depth of cut, the relation between wear-land area and feed force is developed.

The Application of Cemented Carbides for High-Production Broaching..60—WA-117... By Carroll Edgar, Mem. ASME, University of Delaware, Newark, Del. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

The application of cemented carbides to production broaching has revolutionized the design of broaching machines. Speeds have advanced from 60 or 80 sfm to several hundred sfm, with virtually no vibration in the drive. Scientific techniques applied to both brazed-on and clamped-on carbides for broach teeth have practically eliminated cracking of carbides. Similarly, advanced designs of broach sections (or details) have reduced braze stresses to a minimum and increased the number of pieces broached, per sharpening. Finally, where applicable (particularly on cast iron and nonferrous products) much faster production has been attained and with better finishes. Additionally, dual fixtures and automatic cycling have further stepped up production, on the reciprocating types of machines. The application of the tunnel type model has permitted continuous, nonstop production in many cases.

Prior to about 1952, broaching was limited to the use of high-speed steel broaches, primarily because there were no broaching machines available having adequate speed to avoid the formation of a built-up edge on the cutting teeth.

With an entirely fresh concept of the whole problem, a new and a thoroughly up-to-date broaching machine of the horizontal type was designed and built. The drive was electric, of the motor-generator type, applied through herringbone-type gears, to the moving broach holder, which in turn moved on phenolic-type pads to reduce friction. Original speeds were incorporated to range from about 15 sfm to over 400 sfm. The overall length of this first machine was approximately 50 ft. All controls were automatic-controlled by microswitches. Acceleration to desired speed and deceleration from this speed were accomplished within about 4 to 5 ft of the beginning and ending of the required stroke. A further consideration was the addition of a refrigeration unit for maintaining the coolant at a fairly low temperature of around 40 F, together with an appropriate filter for cleanliness. An air blast was provided for chip scavenging from around broach teeth, particularly if the broach was operated without coolant.

Such a machine tool proved to meet every requirement for fast, precision broaching with cemented carbides.

Gage Laboratory—Whys (Wise) and Means..60—WA-308... By Mary E. Hoskins, The Sheffield Corporation, Division of Bendix Corporation, Dayton, Ohio. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

In this day of increasing precision in the manufacture of strategic as well as other forms of equipment, a gage laboratory within a plant has become a vital necessity. For the five basic elements of such a laboratory, Col. William Darmody of the author's company has coined the word "SWIPE," which may be broken down as follows: S—the Standard; W—the Workpiece; I—the Instrumentation; P—Personnel; E—Environment. The paper explains the manner in which these terms apply to the setup of a gage laboratory.

Applications for Ultrasonic Welding of Aluminum..60—WA-322... By J. R. Terrill, F. R. Collins, and J. D. Dowd, Aluminum Company of America, New Kensington, Pa. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

Ultrasonic welding is a modern method of joining aluminum. In less than a decade it has progressed from the laboratory stage to a production joining method. Ultrasonic welding can join the difficult-to-weld combinations such as foil-to-foil, foil-to-plate, and aluminum to other metals such as steel and copper. It is superior to existing joining methods for welding aluminum alloys for structural applications and everyday use. Higher strength joints without any annealed or melted zones are obtained with little or no surface preparation. There is no minimum gage that cannot be ultrasonically welded, but the upper limit with present welding equipment is $1/8$-in. aluminum.

Some of the problems associated with ultrasonic welding, such as a better method of power monitoring, have been solved. Other problems such as tip

sticking, developing more versatile higher capacity machines for welding thicker gages, and lower cost of ultrasonic welding equipment are being studied and should soon be solved. Basic problems such as making ultrasonic welds other than lap welds are also being studied.

This paper briefly covers the development of ultrasonic welding, the types of welding equipment available, and in some detail the operation of an ultrasonic welder. Greater emphasis is given to new uses of ultrasonic welding in structural applications such as automobile, aircraft, and missile construction, in electrical applications and in fabrication of consumer products. Also briefly covered are some of the problems of ultrasonic welding and the related research work currently being pursued.

A Study of Shear-Spinnability of Metals..60—WA-187...By Serope Kalpakcioglu, The Cincinnati Milling Machine Company, Cincinnati, Ohio. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.**; available to Oct. 1, 1961).

The problem of fracture during forming operations is an important subject in the metalworking industry. In any operation it is desirable to predict beforehand whether a workpiece of given dimensions and properties will withstand the strains and stresses imposed upon it without fracturing. The present paper deals with an analytical study of the problem to explain the experimental results obtained in spinnability tests, including also the problem of back extrusion in shear-spinning.

The deformation zone in shear-spinning is idealized for a two-dimensional process and maximum permissible thickness reduction without fracture is predicted in terms of the stress system in this zone. The effect of deviation from the sine law on the maximum reduction before fracture is shown analytically to be due to the influence of distortions of the upspun flange on the state of stress under the roller. The results of analytical work are compared with experimental data and good agreement is obtained. The phenomenon of back extrusion in shear-spinning is shown to be the result of a compressive stress in the spun section parallel to the mandrel side and is greatly influenced by mandrel angle and deviation from the sine law.

Two Quick Nonparametric Statistical Tests for Use by Engineers..60—WA-243...By B. S. Brown, E. I. du Pont de Nemours & Company, Inc., Wilmington, Del. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

Whenever data are presented, an implicit question is asked "Does it justify an optimistic or a pessimistic view of an idea?" In some cases the answer is straightforward; in some, difficult. A complication arises, however, because different individuals view data in different ways. Some see the absolute level, some see the spread in the data, some tend to weight some points heavily, some would discard certain points. Almost any set of data, when "pushed and pulled" enough, can be made to support almost any conclusion. Clearly, impartial and consistent methods are needed for the evaluation of data.

Statistics provides such methods; however, most classical statistical methods are specialized, time consuming, and too intricate for general use by people not trained in the field of statistics. There are, however, a number of quick nonparametric statistical methods which are suited for use by nonstatisticians.

Two of these techniques are proposed here for two frequently encountered problems: (*a*) Are two items different? (*b*) Does a correlation exist in paired data? The techniques are quick, simple, widely applicable, and require remembering only two counting procedures and the two integers 7 and 11.

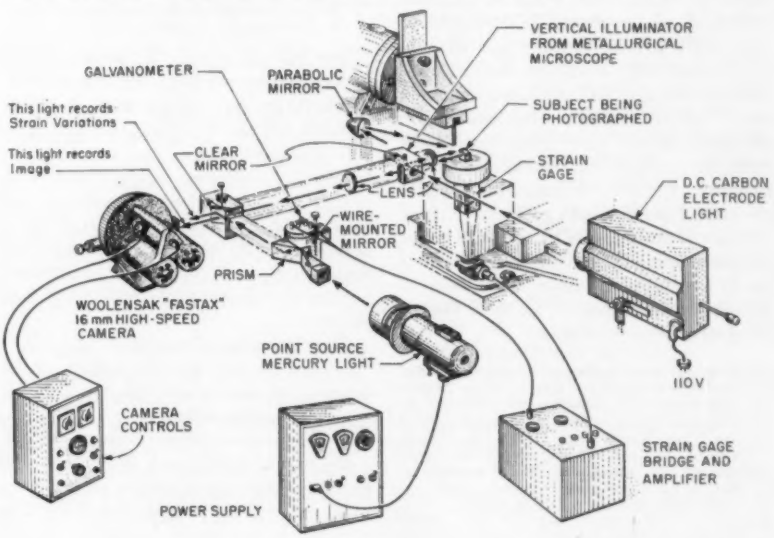
Basic Formation of Chips..60—WA-282... By S. N. Agrawal, Ingersoll Milling Machine Company, Rockford, Ill.; R. D. Harris, University of California, Los Angeles, Calif.; and B. H. Amstead, Assoc. Mem. ASME, The University of Texas, Austin, Tex. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

In order to establish the fundamentals related to the orthogonal cutting of metals, this study closely associating high-speed motion pictures taken at high magnification with tool forces was undertaken. This paper reports the technique used as well as initial results. Pictures were taken at approximately 4000 frames per sec at a magnification of 5× and a moving spot of light or pip indicating the tool force was directed to and recorded in concord with the image. When the film is viewed the screen magnification is approximately 200× and discrete data taken 4000 times per sec are retrievable.

The initial results of this research indicate that, at least for materials such as mild steel, a satisfactory analysis of the metal-cutting phenomena would be somewhat as follows:

First there is apparently a compression phenomenon in which the tool compresses the grain boundaries of the workpiece in front of its path. As a result of compression a slight lateral elongation of the material occurs. Then, under high compression the grains in front of the tool are bent forward and are distorted in the direction of the cut. Under these compressive stresses in the direction of the cut and the tensile stresses perpendicular, approximately, to the direction of the cut, the material fails and escapes over the tool in the form of a chip. Grains in the finished surface of the workpiece are distorted; hence, plastic deformation takes place in the chip and workpiece. Because of the higher pressures and temperatures developed, the material in contact with the cutting edge is more viscous in nature than the material in the outer part of the chip, and because of the high degree of strain-

Diagram of equipment for obtaining basic data on metal cutting at high speed and magnification, both with and without the simultaneous recording of tool forces (60—WA-282)



hardening that takes place along the tool face, the growth of cracks in the chip occur from this face toward the center of the chip.

The chip flowing over the tool face, as shown in several high-speed photographs, resemble the bow of a ship ploughing through the water, and analogies to hydrodynamic flow appear plausible.

Some Controlled Metal-Cutting Studies With Resulfurized Steels..60—WA-115... By E. G. Thomsen, Mem. ASME, and S. Kobayashi, University of California, Berkeley, Calif.; and M. C. Shaw, Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.**; available to Oct. 1, 1961).

Cutting tests, including controlled tool-chip contact area and controlled artificial flank wear-land studies, were made with five resulfurized steels having nearly identical strength properties. It was found that the dynamic shear stress was 62,700 psi and appeared to be identical for all steels at the two cutting speeds of 356 and 936 fpm with sulfur contents of the alloys ranging from 0.11 to 0.37 per cent. For the low sulfur steel (S = 0.033 per cent), the dynamic shear stress was found to be 72,000 psi. A comparison of the effective stresses obtained from compression tests with those from metal-cutting tests showed good correlation at equal strains.

The controlled tool-chip contact area and the controlled wear-land studies at feeds of approximately 0.005 ipr and cutting speeds of 318 to 356 fpm appear to indicate that sublayer plastic flow at the tool chip and tool work interfaces was essentially absent.

Nonmetallics in Production Equipment..60—WA-245... By F. J. Staudt, E. I. du Pont de Nemours & Company, Inc., Wilmington, Del. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

Good performance is being obtained with nonmetallic materials of construction in troublesome chemical exposures. However, the absence of any standardization of these new materials and their end products is currently retarding their increased use. Varying quality of the end products is also a detriment to their full use.

To facilitate the use of reinforced plastics in the fabrication of tanks and other operating equipment, the author's company found it advantageous to develop its own standardized designs for certain repetitive items. During 1959, a study was undertaken for design development work on nonmetallic equipment. One purpose of this was to obtain some standardization of the repetitive items used in reinforced-plastics construction, such as nozzles and flanges.

These have been used successfully for over a year on many pieces of equipment. It is hoped that these designs might be the start of some national standardization for these products, which can economically solve many problems in most industrial plants.

Gas Turbine Power

The Measurement of High-Frequency Fluctuations Between Impeller Blades in an Operating Gas-Turbine Compressor..60—WA-337... By Peter K. Stein, Arizona State University, Phoenix, Ariz. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

Some of the work done by the author in early 1959 is summarized. Intrablade-pressure fluctuations were measured on an impeller in an operating gas-turbine compressor. The instrumentation was required to measure and reproduce 15-psi pressure fluctuations occurring at a fundamental repetition rate of 13,300 cycles per sec at 350 F for an impeller with 1-in. blade spacing at its periphery. The problem is solved through the use of commercially available instrumentation so selected and arranged that the first $7^1/_2$ harmonics of pressure-wave form are believed to have been reproduced faithfully. The transducers were mounted on the stationary impeller shroud. Since the data gathered in these tests are proprietary in nature, this paper discusses only the measurement methods used to obtain these data. The assumptions and limitations of the final system are stated wherever possible.

Description of a Marine-Auxiliary 250-KW Variable-Frequency Gas-Turbine-Driven Generator Set..60—WA-297... By G. R. Wagner, Bureau of Ships, Department of the Navy, Washington, D. C.; Leo Cohen and D. J. Todd, Thompson Ramo Wooldridge, Inc., Cleveland, Ohio. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

The gas-turbine engine is being utilized in an increasing number of installations requiring lower weight and smaller volume than can be obtained with other types of prime movers. The present paper presents a description of components of a 250-kw variable-frequency generator system driven by a gas turbine. The complete generator-set assembly, a brief description of the over-all performance and operation of the 250-kw variable-frequency generator set is presented.

Aerodynamic Design and Development of the General Electric CJ805-23 Aft Fan Component..60—WA-270... By L. C. Wright and R. A. Novak, General Electric Company, Cincinnati, Ohio. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

The procedures used in the design of a high-pressure ratio (1.60), axial-flow, single-stage fan component for the General Electric CJ805-23 aft fan engine are presented. The importance of a relatively complete three-dimensional design procedure (which was applied interior to the blade rows as well as between them) to effective design and design control is stressed. Experimental performance is compared with the design values.

The experimental results indicated:

1 The use of the more complete radial equation of motion gives good results for highly loaded axial stages.

2 The test-stand performance of P_R = 1.655 η_{ad} = 0.872, and $WV\bar{\theta}/\delta$ = 257 exceeded both the objective performance of P_R = 1.60, η_{ad} = 0.82, and $WV\bar{\theta}/\delta$ = 250 and the calculated design.

A Study on Design Criteria and Matching of Turbomachines: Part B—Compressor and Pump Performance and Matching of Turbocomponents..60—WA-231... By O. E. Baljé, Mem. ASME, Hollywood, Calif. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Power;** available to Oct. 1, 1961).

In Part A of this paper a similarity concept for turbines and positive-displacement expanders was presented, which led to the conclusion that the maximum obtainable efficiency of these machines, together with the optimum design geometry, based on the state-of-the-art knowledge, can be presented as function of the similarity parameters specific speed N_s and specific diameter D_s for constant values of Reynolds numbers Re and Mach numbers **M**. Since only these four parameters, or equivalent values, are needed to describe the characteristic of turbomachines, this concept can provide fairly complete information for the design of efficient turbomachines.

In this part of the paper it is attempted to provide similar information for pumps and compressors and to expand the similarity concept for finding the optimum match of turbocomponents operating in closely coupled flow systems. By expanding the similarity concept to compressors and pumps, N_sD_s-diagrams can be computed which give valid information on the maximum obtainable efficiencies and optimum design geometries for these machines and account for the limits imposed by Mach number, Reynolds number, and cavitation aspects.

Heat Transfer

Local Pressure Gradients for Subcooled Boiling of Water in Vertical Tubes..60—WA-249... By W. L. Owens, Assoc. Mem. ASME, University of Aberdeen, Scotland, U. K.; and V. E. Schrock, Mem. ASME, University of California, Berkeley, Calif. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

When a subcooled liquid flowing in a tube is heated at a sufficiently high rate, nucleate boiling will occur on the surface. Small bubbles grow rapidly in a thin superheated layer adjacent to the wall and then collapse as they extend into the main body of the subcooled liquid. This action increases the pressure drop beyond that occurring for the same flow without subcooled boiling. This paper reports the results of an experimental investigation of the pressure drop occurring in forced convection boiling of subcooled water in circular tubes.

This work was undertaken primarily to obtain a method for predicting pressure locally between the inception of subcooled boiling and bulk boiling. Since the test-section wall temperatures were needed to determine the point of inception of boiling, the measurement of heat-transfer characteristics was included.

A Variational Method for Laminar Heat Transfer in Channels..60—WA-98... By H. C. Agrawal, Indian Institute of Technology, Kharagpur, India. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

The importance of variational methods in the study of heat-transfer problems has not been generally recognized. It is a powerful tool for getting sufficiently accurate numerical results in a short time when complicated geometrical shapes are involved and where the analytical methods cannot be applied.

In a numerical example considered there, the temperatures and the mean mixed temperatures were found to be in good agreement with the exact solutions, but the gradients of the temperature at the walls (maintained at constant temperature) and hence the total local Nusselt numbers, Nu, were in error. This discrepancy has been removed in the present work. A method for choosing an appropriate temperature profile in the form of a polynomial is developed. The unknowns involved are evaluated by imposing certain conditions on the temperature and its derivatives on the walls; the conditions can be deduced from the governing differential equations. The Nusselt number at infinity, Nu, can be quickly estimated to the desired degree of accuracy without detailed calculations of the temperature by satisfying a sufficient number of boundary conditions at the wall.

Illustrative examples which include (*a*) parabolic flow, (*b*) slug flow between two semi-infinite parallel plates, (*c*) parabolic flow, (*d*) slug flow in a tube of circular section, are given, and comparisons are made which show good agreement with exact solutions. A brief description of the variational principle for steady heat transfer in channel flows is given, followed by specific problems.

Machine Design

U-Springs—Stress and Deflection Calculations..60—WA-172... By Joseph E. Fleckenstein, Assoc. Mem. ASME, Johnson Service Company, Milwaukee, Wis. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

U-springs in general have some characteristics that may be used advantageously in many machine-design applications. They are (*a*) linear, (*b*) can be manufactured with relatively simple machinery, (*c*) easily mounted, and (*d*) neat in appearance. In addition, to these properties, discriminately designed U-springs of the type shown in this paper have features that are especially useful in instruments and similar precision devices.

The form of U-spring shown is termed a "double cantilever-cantilever." It produces no torque perpendicular to the axis of displacement or torque along the axis of displacement unlike most compression helical springs, which produce both types of torque. This particular feature eliminates frictional forces at guides and pivots. The double cantilever-cantilever U-spring may also be used as a tension spring as well as a compression spring; the same mount may be used.

The stresses and deflections in four types of U-springs are analyzed here through application of Hooke's law of elastic deformation. The final equations are then simplified, largely by the introduction of a parameter, to facilitate industrial applications of U-springs. Because the moments, stresses, slopes, and deflections at points in the springs can be calculated readily with the presented treatment, it offers certain advantages over other possible methods.

Also presented are the observations of experiments that were conducted to confirm the derived expressions. Accurate correlations are reported. The paper concludes by illustrating the merits of discriminately designed U-springs. Brief comparisons are made to other types of energy-storing devices, such as coil springs and torsion bars.

Tension Variations in V-Belts Applied to Locked-Center Drives..60—WA-307... By K. G. Hornung, S. M. Marco, and W. L. Starkey, Assoc. Mems. ASME, The Ohio State University, Columbus, Ohio. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

Historically, a great amount of effort has been expended in an attempt to explain completely the variation in the belt tensions occurring in a belt drive as the torque on the driven pulley changes. These variations are particularly difficult to explain and to predict when the drive is of the type in which the pulley center distance is held constant while the torque varies.

This latter problem has been the object of considerable study by the authors. The paper represents a report on that study, made of the various physical phenomena involved in the establishment of the belt tensions in a V-belt drive operated at high speed and under a torque load while the pulley-center distance is held constant. In the course of the study the equation of the belt curve between pulleys is derived and this equation is then integrated to give the free length of belt included between the pulleys. Experimental results are given and indicate excellent agreement between predicted and measured tensions.

Loosening of Bolted Joints by Small Plastic Deformations..60—WA-116... By O. A. Pringle, Assoc. Mem. ASME, University of Missouri, Columbia, Mo. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

An important requirement for the satisfactory performance of a bolted joint is the retention of a suitable clamping force. Decrease or loss of clamping force may result in such detrimental effects as slip, misalignment, slack, leakage, and reduced fatigue strength. Unfortunately, loosening can occur in a variety of ways, among which are rotation of the nut; crushing of surface irregularities; extrusion of dirt, paint, plating, or scale; creep; and plastic deformation.

This paper examines in detail several cases in which loosening is caused by plastic elongation of the bolt.

Formulas are derived for several cases of loosening of bolted joints caused by stresses in excess of elastic limits and accompanying permanent deformations. It is shown that loosening occurs during the initial application of an external force, but that subsequent repetitions of

the same force cause no further loosening. External impact loads, which require a definite energy absorption of the joint, result in loosening upon both the initial load application and later repetitions. The effects of initial tightening, gaskets, and spring washers are investigated. Loosening under moderate loads may be completely avoided if the initial bolt tension does not exceed a certain maximum value. Loosening is unavoidable under extremely high loads, but the amount of loosening can be decreased by use of higher initial tensions. Illustrative experimental data are reported.

The Centrifugal Clutch Coupling..60—WA-173...By James E. Ettorre, Mem. ASME, The Hilliard Corporation, Elmira, N. Y. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

Centrifugal clutches permit rapid acceleration of a motor to peak torque and appreciably reduce motor current and heating. They also provide an automatic means for connecting an internal combustion engine to its load by simple throttle control.

Overdesign (the selection of a clutch of larger capacity than necessary) often results in pulling down the driver's speed so that optimum performance is not realized.

An understanding of the factors that affect the capacity of the centrifugal clutch is important in determining the proper selection. A centrifugal clutch-coupling that can provide for misalignment between the driving and driven machines without significant impairment of its speed-torque properties provides a compact and economical arrangement.

The paper describes some typical applications of the coupling—pointing out the features used to particular advantage on each installation.

Hydraulics

An Investigation of Axial-Flow-Pump Design..60—WA-36...By Y. K. Gayed and S. Mikhail, Cairo University, Giza, Orman, Egypt, U. A. R. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

Recently several of the items which constitute an axial pump have been considered both analytically and experimentally. The method of design, however, is still based on single aerofoil results obtained over twenty years ago, modified perhaps by more recent tests on thin hydrofoils. A procedure which pieces together the results of investigations on blade cascades as affecting the duty of the pump and the speed limitations set up by cavitation is still lacking. It is to fill this gap, at least in part, that this exposition is made.

Note on Observations of Cavitation in Different Fluids..60—WA-83...By L. R. Sarosdy, Lieutenant, U. S. Navy; and A. J. Acosta, Assoc. Mem. ASME, California Institute of Technology, Pasadena, Calif. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to Oct. 1, 1961).

Many observations have shown that the performance of a centrifugal pump with different fluids or with the same fluid at different temperatures is not the same at the same cavitation number when the latter is based upon the vapor pressure of the bulk fluid. Various similarity rules have been put forward in these works to account for the observed effect; namely, that lower net positive suction heads are achievable in most cases compared to those observed in cold tap water. This difference is ascribed to the thermal effect associated with evaporating a certain fraction of the bulk fluid and the attendant decrease of vapor pressure. Scaling rules of the vapor-pressure decrease are made by assuming the process static and that all of the fluid in the inlet of the pump is at the same pressure. Measurements have shown that such a simple concept is inadequate.

The purpose of this note is to describe an experiment intended to show the types of cavitation that occur and, where possible, to measure directly the reduction of vapor pressure or net positive suction head observed in pump experiments.

Nonsteady Discharge of Subcritical Flow ..60—WA-152...By George Rudinger, Cornell Aeronautical Laboratory, Inc., Buffalo, N. Y. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to Oct. 1, 1961).

The calculation of a nonsteady flow discharging into the atmosphere, or into a large reservoir, is generally based on the assumption that the effective exit pressure is the same as if the flow were steady. In reality, however, the steady-flow boundary conditions are asymptotically approached after a disturbance produced by an incident wave, and recently published investigations provide a better approximation to these transient boundary conditions. Utilizing these results, one can compute the rate of discharge and compare it with the rate obtained in the conventional manner. The difference between the results of the two calculations is used to define a lag error in the conventional calculations.

Examples for discharges through an open end and through a sharp-edged orifice indicate that the actual transient flow rate may deviate considerably from that computed on the basis of steady-flow boundary conditions.

Transport Processes Involving a Moving Rotating Disk in a Low-Density Gas..60—WA-154...By S. L. Soo, Mem. ASME, University of Illinois, Urbana, Ill. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to Oct. 1, 1961).

The fluid mechanics of a spinning body moving at a high speed in a low-density medium has considerable practical interest. A simplified situation of such a spinning body is a rotating disk with forced axial flow of a gaseous medium.

At very low pressures, the relations of momentum and energy transfer of free-molecule flow toward a rotating disk can be calculated easily, as shown in this paper.

At higher intermediate pressures in the microns of mercury range where slip motion occurs, however, the calculation requires a solution to the problem of compressible boundary-layer motion in a rotationally symmetric system.

An analytical method is presented for studying the compressible boundary-layer motion over a rotating disk including axial forced flow. Some existing incompressible flow data can be utilized. The range considered includes free-molecule flow, slip flow, and high-density gas flow. A new correlation for treating disk-friction data is suggested. General aspects of friction and heat transfer are discussed. Results suggest the rotating disk as a suitable tool for experimental study of mechanics of a rarefied gas.

Ejector-Nozzle Flow and Thrust for Choked Flow..60—WA-155...By H. E. Weber, Assoc. Mem. ASME, General Electric Company, Danville, Calif. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to Oct. 1, 1961).

The prediction of thrust and flow for fully expanded and underexpanded ejector nozzles, whether the shroud is cylindrical or divergent, has been handled in several ways with good results. However, it has not been easy to calculate the thrust of any ejector nozzle when the secondary and primary streams are both choked but the nozzle is overexpanded with compression or shock waves between the primary nozzle and shroud exit.

A theory for the prediction of flow for fully choked divergent shroud nozzles has been compared with experiment and corrected empirically. The prediction of thrust has been extended to include both

the underexpanded and overexpanded flow regimes in this type of nozzle. Comparisons with the theory have been made and good correlation found in both overexpanded and underexpanded regimes of flow.

The Flow of Water in Curved Channels of Large Width of Radius Ratio..60—WA-164...By A. W. Marris, Assoc. Mem. ASME, University of Texas, Austin, Tex. 1960 ASME Winter Annual Meeting paper (multilithographed; available to Oct. 1, 1961).

The flow of water in the curved channel between concentric circular walls is investigated for three channels each of large width-to-radius ratio. The channels are also of large depth-to-width ratio.

The report is divided into three parts:

1 The development, from visual observations of the free-surface topography for open flow in the curved channels, of a flow model describing the initial effect of curvature on rectilinear flow.

2 The quantitative investigation of pressurized flow in the channels through measured radial distribution of mean peripheral velocity, static pressure, and total head.

3 A discussion of the data obtained in the light of the equations of turbulent energy production.

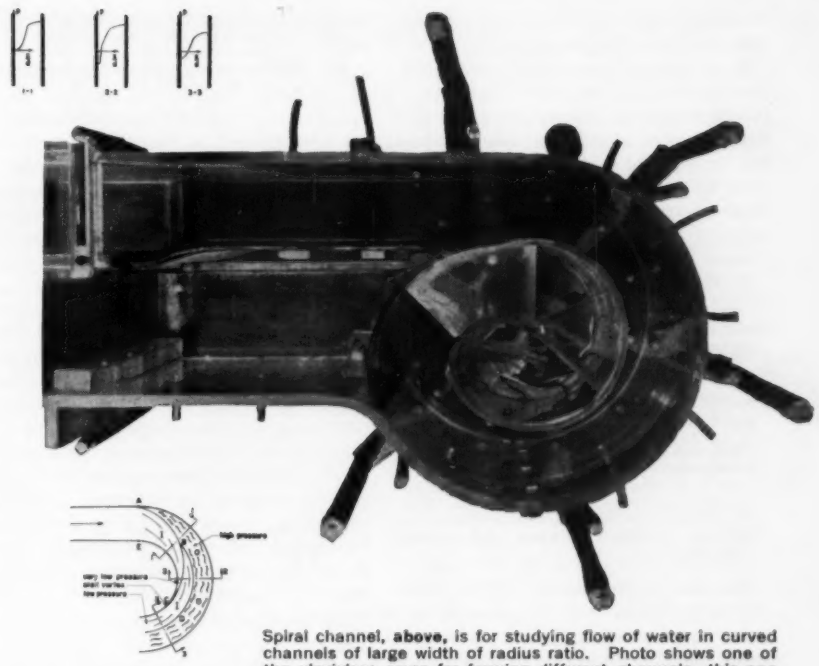
In summary, visual observations of the free-surface topography showed that when water, initially in rectilinear flow, enters a curved channel, it becomes divided into two regimes:

1 A crescent-shaped outer region of energetic turbulence, high radial diffusivity, over-all high pressure, and corresponding low mean velocity, which diverges as a separated boundary layer from the point where the curvature begins; i.e., when the flow-wise pressure gradient becomes adverse.

2 An inner region of low radial diffusivity, low pressure, and correspondingly high velocity caused by the sudden decreases in static pressure at the beginning of the curvature of the inner wall.

Effects of Inlet Conditions on Performance of Two-Dimensional Subsonic Diffusers..60—WA-143...By B. A. Waitman, Assoc. Mem. ASME, Jet Propulsion Laboratory, Pasadena, Calif.; L. R. Reneau and S. J. Kline, Mem. ASME, Stanford University, Stanford, Calif. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to Oct. 1, 1961).

In general, flow in passages with favorable pressure gradients is amenable to known design methods and gives predictable stable flow patterns. However, flow in diverging passages, such as diffusers, contains a number of unknown elements.



Spiral channel, **above,** is for studying flow of water in curved channels of large width of radius ratio. Photo shows one of the plexiglass cores for forming different channels—this one allowing water to spiral into the center. Pressure gradient diagrams, **at top,** show increase in static pressure at outer wall that causes separation. **Bottom** sketch shows the three locations of the pressure plots. (60—WA-164).

Performance data and flow characteristics for subsonic two-dimensional plane-wall diffusers are presented for the following conditions. (*a*) Wall-length to throat-width ratios of 8.0, 12.0, and 48.0, (*b*) total divergence angles from 2.5 to 40 deg, (*c*) extremely thin inlet boundary layers to fully established channel flow, (*d*) a vaned diffuser with $L/W_1 = 8.0$ and quite thick inlet boundary layers. Flow conditions and variations of flow regimes for $L/W_1 = 48.0$ are compared. No real gain in recovery or pressure effectiveness is achieved by use of very large L/W_1. $L/W_1 = 20 - 25$ appears to be maximum useful range in the absence of boundary-layer control. A few data are given where the inlet flow of the diffuser is distributed by obstructions. Recovery and effectiveness are found to be strongly dependent on type and amount of inlet turbulence.

Management—Ten Years' Progress, 1950–1960[1]

Fifty Years of Management—A Look Back and a Look Forward..60—WA-46...by Peter F. Drucker, New York University, New York, N.Y. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.**; available to Oct. 1, 1961).

Management as a specific discipline and a specific kind of work, with a specific function in society and economy, was developed almost entirely within the past 50 years. In the ten years between 1910 and 1920, the decade of the first World War, all of the following great themes of management evolved:

1 The systematic study of work.

2 The systematic study of effort, results, and organizations.

3 Managerial and entrepreneurial economics.

4 The social position and responsibility of management.

5 The human relations of an industrial society and the place of the individual in it.

Each of these approaches was developed independently, and has remained separate to this day. Each has made great advances, especially during the last decade. Part of this report is devoted to recounting and presenting these advances.

The author asks: Can these different approaches remain different much longer? Or are we fast reaching the point where

[1] While the foregoing papers are available separately, they are also included in the volume entitled, "Fifty Years' Progress in Management," priced at $10.50 a copy ($8.40 to ASME members).

we need what, so far, we have not achieved: a unified discipline?

He discusses an even more compelling reason why the end has come to the period during which separate approaches to the study of management could profitably be pursued: Management has become world wide. It is needed the most in those countries that do not have a managerial tradition, in the "underdeveloped" countries.

It is concluded that from now on "management science" and "scientific management," "managerial economics" and "human relations" will have to be made one in the theory as well as in the practice of management.

Practices in Operational Management—Engineering Management..60—WA-50... By C. E. Paules, Esso Research and Engineering. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.**; available to Oct. 1, 1961).

Inherent in the history of the engineering profession has been constant advance in its methods of carrying out its tasks and ever-improving quality of its work output. In this country, it has played a major role in aiding the development of the United States into its leading industrial position. Seldom in this history has the engineer been confronted with a challenge—to think and to perform—equaling that of the past decade.

The author discusses the problems and advances in engineering procurement, training, and organization; the use of new tools and methods, such as the computer; and of new activities, such as reliability engineering.

In the light of new techniques, he discusses budgeting, as well as project selection and project management.

He concludes that although much has been accomplished during these years by streamlining organizations, improving engineering training, and utilizing new techniques, much more remains to be done in securing the maximum benefits of engineers.

The Philosophy of Management..60—WA-55... By L. Urwick, Mem. ASME, Urwick House, London, England. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.**; available to Oct. 1, 1961).

Management is a practical art. In the development of a new body of knowledge about a practical art it is of importance that theory and practice be integrated.

Discussed in this paper are: The development of education for management, executive development and its effects, particularly its indirect effects on management education; and the professionalization and internationalization of management.

The author notes that the development of electronic calculating devices has opened up the possibility that business may be assisted to marshal the facts bearing on decisions of many kinds and to precalculate the effects of decisions susceptible to statistical treatment, on a scale and at a speed which may well revolutionize many established methods of management.

He concludes that apart from the danger of a false scientism, probably the most serious symptom that management philosophy is not as healthy as it might be, is the immense confusion of its terminology, there being no standard or accepted definitions of the vast majority of the terms used in writing about it. It is not exaggeration to suggest that as a subject it is engulfed in a semantic swamp. Until that situation is corrected any development of a common understanding of principles and practices is gravely handicapped.

Philosophy of Management..60—WA-56... By A. M. Lederer, Mem. ASME, A. M. Lederer and Company, Inc., New York, N. Y. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.**; available to Oct. 1, 1961).

The author states that there has been no progress in "philosophy of management" because there had not been formulated at any given point of time an exposition of a philosophy of management, the validity of which could have been tested and generally accepted, and the progress of which could have been measured through its acceptability.

In suggesting the dilemma, he points up where the fundamental error in the quest for a philosophy of management lies; that the act of managing, based on certain formulated knowledge, intuition, and desire, is something distinctly different, separate, and apart from the whole of man's character and philosophy. He finds danger in the undisciplined usage of the terms "management" and "philosophy," saying that if such usage continues and the error of separateness is not corrected, no valid philosophy of management will emerge.

He concludes that the act of managing the mass body of knowledge can have no philosophy but that the perpetrator and the user of the act does. The multitudinous interrelationship between men, each a manager, demands that a philosophy can be found upon which all functional and other theories and principles of managing can be built. The search then is not for a philosophy of management but a *philosophy of managing*.

He states his belief that a philosophy of managing applicable to all men can and probably will be postulated in the years to come, and that all current theories will be re-examined.

Practices in Operational Management—Distribution Management..60—WA-57... By J. R. Hawkinson, Northwestern University, Evanston, Ill. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.**; available to Oct. 1, 1961).

The past ten years have seen a number of major developments in distribution management, increasingly referred to as marketing management. One of the most dynamic and basic, which has come to be known as the marketing concept, emphasizes the importance of understanding the market thoroughly. The market is defined as those who buy and use a company's products and services. This marketing concept has been defined as: A corporate state of mind that insists on the integration of and co-ordination of all of the marketing functions which, in turn, are melded with all other corporate functions, for the basic objective of producing long-range corporate profits.

The author discusses the influence of the market on company decisions to increase the amount of marketing research; product planning for a more balanced product line; and the dramatic growth of distribution channels, such as supermarkets in the food field.

Marketing planning in the last decade is also discussed. It is noted that the greatest organization change in marketing has been in the increased stature of the chief marketing executive's position. Among the titles used today are vice-president for marketing, or manager of marketing, or director of marketing. Under him have been placed generally all the related marketing activities. This contrasts with the earlier situation where the sales manager operating the field sales force was the chief distribution executive.

Greater use of staff positions has allowed for more specialization throughout the marketing organization, and for increased planning and co-ordination by the top executive.

It is concluded that the total marketing effort has been more profit oriented in the past decade. It has achieved the point of view of top management that sees the total picture rather than a departmental activity.

Practices in Operational Management—The Management of Industrial Research..60—WA-58... By Harold K. Work, Director, The Engineering Foundation of United Engineering Trustees, Inc., New York, N. Y. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.**; available to Oct. 1, 1961).

Research promotes change and probably the only rule for management of industrial research on which all can agree is that the approach of management must change with the changing times and the changing position of industrial research.

The present interest in developing management techniques for industrial research is a direct result of the growth of this activity into a tremendous industry in itself.

The objectives of industrial research are discussed, as well as the question: Can or should research be directed and programmed? The problems of research productivity and the evaluation of results are briefly discussed.

Practices in General Management; New Directions for Organizational Practice..60—WA-59... By B. J. Muller-Thym, Management Consultant, New York, and Visiting Professor of Industrial Management, Massachusetts Institute of Technology, Cambridge, Mass. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.;** available to Oct. 1, 1961).

The advance in the practice of organization in the decade 1950–1960 came by way of departure from the practices of 1910–1950. The decade of the 1950's was characterized by the emergence of new institutions.

The body of organizational practice of the period from 1910 to 1950 is summarized, and followed by a résumé of improvements in that practice that began before the 1950's. These included attempts at decentralization, human relations, and the introduction of dynamics into the system.

By 1950, the state of organizational practice was characterized by:

1 The development of pyramidal, many-layered, highly functionalized structures, embodying such "principles" as span of control and the like.

2 The attempt to humanize such structures or bring them under control or help people adjust to life within them.

3 The elaboration of special bodies of "how to" knowledge—for example, how to organize the marketing function, the market research function, the district sales manager's job.

The sources of these developments is discussed, as well as the emergence in the 1950's of the product manager, the professional sales job, and the management of a productive matrix.

The author also reviews advances in organization made by the government, particularly in the Navy's Polaris project; and advances made from the use of material of the social sciences in running a business; and concludes with a discussion of the top-management task of large-scale business design.

Practices in Operational Management—Manufacturing Management..60—WA-60... By Harold B. Maynard, Fellow ASME, Maynard Research Council, Pittsburgh, Pa. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.;** available to Oct. 1, 1961).

The decade of 1950 to 1960 witnessed a number of major technical advances in manufacturing procedures. Productivity was increased importantly both through automation and the simplification of manual methods. Good plant layout was increasingly recognized as a means of securing "built-in" efficiencies. Improved work measurement procedures permitted the measurement and control of indirect as well as direct labor. Initial attempts to measure supervisory and engineering activities gave promise of coming advances in these areas. Cost-reduction activities where properly organized were outstandingly successful. Wage-incentive methods were improved and older out-of-line installations were revamped. New developments were introduced in inventory management and production planning and control. Statistical quality-control procedures were widely applied and quality improvement through thorough operator training was found to be realizable.

But the technical developments often surpassed management's readiness to use them. Thus progress in manufacturing was spotty, with brilliant successes and dismal retrogressions at either end of the spectrum. The author concludes that the reasons for this are correctable, however, and that if managers in the 1960's will concentrate on the adoption of new techniques as they come along and the solution of the "people" problems of which they themselves may be a part, there is every reason to feel optimistic about the continuing strength of the American economy.

Management as a Profession..60—WA-61... By Harold F. Smiddy, Mem. ASME, General Electric Company, New York, N. Y. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.;** available to Oct. 1, 1961).

Management as a profession is a tricky topic to talk about with precision because it embraces two fundamental concepts—that is, What is management? and also, What is a profession?—plus the neat question of compatibility of the two. To do so and also talk about "Ten Years Progress From 1950 to 1960" introduces added difficulties to appraise the situation in some visualizable way, first at the start of the decade and then at its end, in such terms that the ensuing change may itself be significantly sensed.

Discussed here are the nature and purpose of professional work, the transition from "scientific" to "professional" managing, and the concept of management as a profession. Included is a chart on "The Work of a Professional Manager," and a section of comments of management leaders.

Management Education—Colleges and Universities..60—WA-62... By E. P. Brooks, Massachusetts Institute of Technology, Cambridge, Mass. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.;** available to Oct. 1, 1961).

In the field of education for management the decade of the Fifties was a period during which the universities and colleges having schools in this field underwent a soul-searching and self-criticism which in all probability will bring about marked changes.

In some ways a few universities in the late Forties were working toward the changes that were to characterize the Fifties. By 1950, the focus of attention in education and in industry was shifting to the question: How should a company go about training and developing its people in the many complex functions of a modern enterprise embracing the fields of finance, control, production, marketing, and especially the integration of all of these into general management?

It is the purpose of this paper to review some of the developments which took place progressively during the decade of the Fifties in the field of education for management in our institutions of higher learning. These developments are taken up under the following headings:

1 The interrelationship between industry and the schools.

2 The age levels for training and development.

3 Curriculums.

4 Research in economic-managerial fields.

Practices in Operational Management—Personnel Management..60—WA-64... By C. E. French, Industrial Relations Counselors, Inc., New York, N. Y. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.;** available to Oct. 1, 1961).

Personnel administration in the past decade held many challenges for management. Problems posed by two closely occurring recessions, by crises in labor relations, and by a continuously expanding economy brought about a questioning attitude in management circles and a reappraisal of the merits of traditional approaches in administering personnel matters. The decade was characterized by strong executive leadership in employee relations, a more outspoken approach in communicating with em-

ployees, and a more assertive attitude on the part of management in dealings with organized labor.

These overriding developments reinforced an approach to personnel policy that is designed to keep it flexible and, therefore, more attuned to the times. Thus some traditional concepts were discarded, emphasis shifted, and on the whole management made bold strokes in its effort to resolve the problems it faced. Whatever may be the problems of the future, managerial sensitivity to the need for a dynamic personnel program bodes well for the administration of employee relations in the next decade.

Management Science..60—WA-65...By E. H. Weinwurm, De Paul University, Chicago, Ill. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.**; available to Oct. 1, 1961).

Management science is not yet an established branch of science. Its aims and purposes can easily be described in broad terms but an agreed definition, which is an indispensable prerequisite of an established field, is not yet available.

First of all, those interested in management science have approached it from some other area of research. Their peculiar background could not help but influence their opinion regarding the scope, objectives, and methods of the new science.

Also, the rehas been the apparent need to emphasize the practical applications to convince business executives of their usefulness for management purposes. This has led to a concentration of attention to results at the expense of research on fundamentals.

Admitting the difficulty in presenting a well-rounded picture of the concept of management science at the present stage of its evolution, the author discusses some of the principal points of view that have been suggested during the past decade. His discussion assumes a dominant position for management science in the sense that its task would be to serve as a co-ordinating agency for all the other sciences and techniques connected with or interested in problems of managerial decision-making.

He discusses operations research, concluding that it will continue as an important factor in supporting advanced and improved methods of managerial decision-making in the years to come; and then reviews decision theory and organization theory. Also reviewed are a number of old and new techniques that have contributed to the accomplishment of the purposes of operations research and managerial decision-making.

At this stage in the development of management science, he recognizes two principal concepts:

1 Management science can never lose or deny its connection with and dependence on the scientific method in its broad scope.

2 Management science will always have to be conscious of its main purpose to serve as an effective tool of managerial decision-making.

Practices in General Management—Financial..60—WA-66...By R. B. Curry, Southern Railway Company, Washington, D. C. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.**; available to Oct. 1, 1961).

Directly or indirectly, the practices of financial management have been influenced overwhelmingly, if not dominated completely, by the economic factors and environmental aspects of the national and international conditions of the past decade—a period of almost unprecedented world-wide prosperity marred by attendant inflationary conditions.

The author makes the following points:

1 Tax planning has become as much a tool of management as budgeting and cost accounting.

2 Management has had to face either making more expensive capital expenditure decisions at times of high interest rates or, conversely, making these decisions at lower interest rates but proceeding at a time of lower business levels.

3 In countries where we have superimposed modern management on low-cost-labor markets, competitive products have come home necessitating increased emphasis on labor-saving devices.

4 The influence of increased costs to industry, the demands of the population explosion, and the conversion of the fruits of military research and development to industrial applications, all constitute important factors in the growth of significant financial practices in management.

The economic environment together with the technological advances of the age have created the dilemma of recovery of capital investment. Even when or if original capital is recovered, its complete inadequacy for equipment replacement because of inflated price levels has failed to meet the cost of just staying in business, much less meeting expanding requirements. For this reason, the terms cash flow, cash forecasting, depreciation, rapid amortization, accelerated charge-off, lease financing, and rent or buy have become permanent features in management's financial handbook. These are discussed, as are the new tools of financial administration, such as office automation.

Management's Past—A Guide to Its Future..60—WA-67...By L. M. Gilbreth, Hon. Mem. ASME, Gilbreth Inc., Montclair, N. J.; and W. J. Jaffe, Assoc. Mem. ASME, Newark College of Engineering, Newark, N. J. 1960 Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.**; available to Oct. 1, 1961).

From management's beginnings as indicated by the Bible, this discussion of the history of management is carried through ASME's early interests in the field and the many papers and discussions by its pioneers, including Taylor, Gantt, Gilbreth, and Alford.

In discussing planning and control in the field, the authors review some of its mechanisms, such as historial costing in production control, and the "two-column system," which was later refined into standard costing; the quota system of control in the sales field; the budget, and the "breakeven chart."

Also discussed is management's search for a standard and a measuring device for work and the evaluation of manufacturing performance.

It is concluded that the engineer cannot afford to consider the contributions of the past inapplicable to the present, and that management needs his technical training and his logical approach.

International Progress in Management ..60—WA-68...By E. Mittelsten Scheid, Vorwerk and Company, KG, Wuppertal-Barmen, Rhineland, Germany. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.**; available to Oct. 1, 1961).

Scientific management assisted many a government in controlling national economy under the emergency of World War II. The period 1950–1960 was the period of restoration of peace-time economy. It was significant for this period that in the free world a strong trend toward a reduced government control of economy was prevailing and instead the evolution of scientific management development schemes in virtually every country produced a more democratic structure of economy.

A definition of the purpose and meaning of management reads as follows:

1 To produce and to offer a specific product or range of products or services at a competitive price to the market.

2 To offer employment to people who cannot make their living in a free profession or on their own land, so that they can earn a wage or salary, which allows them to take care themselves of their human needs.

3 To build up employer-employee relations based on individual freedom.

4 To practice within reasonable limits the responsibility for job security of the employees.

5 To make a profit.

The author outlines the functions of management and its progress in business policy and organization, research and development, planning, production, purchasing, marketing, financing, cost accounting, personnel management, and public relations.

He concludes that management has a long way to go before it will build an industrial world that satisfies equally well management, labor, consumer, and government.

Management Education—Industrial..60—WA-107... By F. F. Bradshaw, Management Consultant, Croton-on-the-Hudson, N. Y. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.**; available to Oct. 1, 1961).

Now, after the passage of the decade of the Fifties, there are obvious shifts in emphasis on the part of management itself in response to the changing environment.

The accelerated rate of environmental change has seemed to call for an accelerated rate of *education for change*. The emphasis upon long-term strategy and planning has called for more emphasis upon *diagnosis*. The awareness of the unique nature of each corporate enterprise, its *corporate image*, its *social role*, its own peculiar linkage with *technology* and the *market-place* seem to make it necessary that the managers have not only managerial experience, but a digest of *natural* and *social science* findings as they relate to the work of the particular corporation and its strategic situation in our present economic and political environment.

The most obvious and dramatic trend in manager education during the past decade is its *quantitative* aspect. Company after company, since 1950, has realized the *shortage* and the *inadequacies* of managers, and has begun to send managers out to universities and, more gradually, has begun the procession of companies setting up some kind of "institute program" of their own, either in rented quarters or on purchased estates, or in buildings especially constructed for the purpose.

In summary, the author states that the American corporation with typical American belief in salvation by education has, since 1950, supported a unique and impressive education revolution which is still in explosive acceleration. Since policies, climates, and budgets are usually set from the top, we may expect to see styles in foreman training increasingly set by results of executive education.

Practices in General Management—Measurements and Control..60—WA-69... By A. W. Rathe, Mem. ASME, New York University, New York, N. Y. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.**; available to Oct. 1, 1961).

Many yardsticks in common use in management today are a residue from the thinking of older times. They record, too often, the impact which just one component makes upon the total picture.

Managing is a cyclical process. As its most basic essentials, the management cycle contains the three elements of:

1 Planning. Goals are established for the organization as a whole as well as for every one of its components. Available resources are examined to determine whether they permit the realization of these targets. This establishes the best way by which the objectives can be reached under the prevailing conditions.

2 Operations. A decision among possible alternative plans is made. Necessary instructions are discussed with all concerned. Activities proceed, under the direction of management, as closely in harmony with the plans as possible.

3 Review. Actual results are recorded and interpreted so as to distill those conclusions out of the effects of operating which are useful for future plans.

For control to be effective, the executive needs more than just review; he has to put into play all three of the key sectors which constitute the manager's realm at every level and on any problem. Review is perhaps best characterized by its service trait in that it, as well as planning, exists solely for the purpose of making better operations possible in the future. Control in the sense of "holding the reins," must remain the prerogative of operations because it is there—and only there—that activities are directed.

Management Education — Professional Societies..60—WA-109... By Clarence E. Davies, Fellow ASME, Executive Director, United Engineering Center Project, New York, N. Y. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.**; available to Oct. 1, 1961).

Professional bodies perform several related educational functions. They encourage the development of new ideas. They recognize praiseworthy achievement by suitable awards. They sponsor research and establish standards. They support all these functions by complete publication service.

These educational services are provided to meet a demand arising from the complexities of engineering, business, and industry. This demand is fundamentally professional requiring that the person who exercises any degree of managerial responsibility shall have some special education at the start of his career and that as he grows in responsibility he shall be further educated or re-educated. These later educational processes are provided in large part by the professional societies.

The purpose of this paper is to report how a selected few bodies carry out their educational functions. The selection, necessary by space limitation, was made to show different methods of operation. It includes, besides ASME, The Society for the Advancement of Management, The American Management Association, and the American Institute of Industrial Engineers.

Practices in Operational Management—Local Government and Other Nonprofit Organizations..60—WA-126... By George M. Goettelman, Consultant, Philadelphia, Pa. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.**; available to Oct. 1, 1961).

During the past decade, there has been a gradual change in the philosophy of operational management among governmental and other nonprofit organizations and institutions. This change has been prompted by the demands of the public for greater return for the tax dollar, both in services and results. The citizen is concerned, more than ever before, by the spiral of increasing costs, taxes, etc., and while he expects to pay for what he wants, at least he wants value received.

This change in philosophy has created a desire for better training of potential managers and has produced a new class of executives, "the professional managers." The achievements of the professional managers in many cases far outrank the results of the managers who have grown up with the organizations. Good training and an objective viewpoint without being inhibited by tradition and internal politics is the criterion of the professional manager.

It is at the local level in our political subdivisions—the grass roots—that some of the greatest changes in the practices of operational management have taken place. During this decade many cities, towns, and villages have felt the impact of this movement and have brought about substantial improvement in their operations. One of these, a large eastern city, is used as an example to illustrate the kinds of changes which typify such progress in municipal governments.

In addition, better educational methods are being seen in the development and use of electronic aids to teaching, particularly closed-circuit television, as a means of bringing the best available in-

struction to large numbers of pupils most economically. While still in the trial application stages, it seems that such new techniques offer promise for both reducing the cost and upgrading the quality of teaching.

The tools of good operational management that industry takes for granted also are just now being utilized in hospitals. During the coming decade, the author states, hospital administration will undoubtedly make greater use of the professional engineers and management consultants.

Practices in Operational Management—The Federal Government..60—WA-169... By Howard K. Hyde, Office of the Secretary of Defense, Washington, D. C. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.;** available to Oct. 1, 1961).

Somewhere in government there appears to exist in use every substantial applicable management idea which has current status. The basic problem is to effect the proper selection and widespread employment of these ideas and to have a full participation in the development of new ones. This was true in 1950 as well as 1960. Basic differences which took place during the decade are the widespread acceptance of the idea that managerial principles have universality (the common idea before 1950 that government is different has substantially given way to the positive belief that differences primarily require intelligent adaptation) and the striking advances which have been made in government in a number of the areas of management.

In some cases it has been largely a matter of catching up with industry. In some, government has been the pioneer. And in many areas, advance has come through free interchange of ideas and experimentation between business, education, and government—a pattern of partnership which grew in strength through the decade and promises to increase to mutual advantage.

The substantial changes in organization that took place during the decade were mostly structural improvements or organization adjustments in recognition of current requirements or of changed circumstances. There was no fundamental change in the largest single organization problem—how to make the President's job manageable.

Recent years also have seen a continuing and expanding use of previously established international organizations with some innovations in the creation of new ones. At the regional level NATO has continued to be a prime agency for co-ordinated defense effort within the Atlantic Community.

Power

Power-Plant Performance Monitoring..60—WA-222... By J. Kenneth Salisbury, Fellow ASME, Consulting Engineer, Atherton, Calif. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Power;** available to Oct. 1, 1961).

The thermal performance of any steam power plant depends only on the *thermodynamic cycle* in which it operates and the *effectiveness of the components* that implement this cycle. By usage the term "cycle" has come to mean far more than a repetitive series of thermodynamic processes. It includes within its connotation items such as initial and exhaust conditions, whether or not reheat is employed, the number and arrangement of feedwater heaters, and the location and number of boiler feed pumps. The term "effectiveness of components" includes elements such as efficiencies of turbines and pumps, terminal differences of feedwater heaters, pressure drops in extraction piping, condenser temperature difference, and mechanical and electrical efficiency. Thus any monitoring concept must embody means for determining the effect on heat rate of changes in the environmental conditions, as well as means for detecting the effect of change in component effectiveness. Considered here are the criteria for component effectiveness, the effect on heat rate of changes in environment, and finally the translation of the basic environmental relationships into criteria for monitoring component effectiveness.

In covering the "deviation-monitoring concept," the paper outlines the theory and fundamental analytical concepts that compromise the basis of automatic performance monitoring equipment currently under development by The Bailey Meter Company.

One of the advantages of the system proposed herein is that the magnitude of the investment in performance-monitoring equipment may be tailored to suit the economics. The proposed system is adaptable to the installation of a very large number or of a small number of transducers and computing elements, each self-sufficient within its own province.

The Application of the Deviation Concept of Turbine Cycle Monitoring..60—WA-166... By H. T. Hoffman, The Bailey Meter Company, Wickliffe, Ohio; and C. P. Welch, Mem. ASME, The Babcock & Wilcox Company, Research Center, Alliance, Ohio. 1960 ASME Winter Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Power;** available to Oct. 1, 1961).

This paper is a report to the power industry on a program being carried on by The Bailey Meter Company designed to provide methods of boiler and turbine cycle analysis suitable for automatic data-processing techniques. The aims of this program are described and the analytical progress to date reported.

Means are presented for identifying cycle faults and determining the change in heat rate resulting from these faults. Very little in the way of precision measurement and calculation is required. These techniques are, therefore, amenable to use by plant personnel with the tools already at hand.

One purpose of this paper is to show how accurately the summation of the changes in heat rate as determined from Salisbury's equations compares with the true change in heat rate for a real cycle as calculated from a complete new heat balance when various equipment faults are introduced into the cycle.

Some Gyroscopic Oscillations, by C. J. Thorne. (60—APMW-15)
Steady-State Behavior of Nonlinear Dynamic Vibration Absorber, by W. J. Carter and F. C. Liu. (60—WA-14)
On the Stability of the Linearly Related Modes of Certain Nonlinear Two-Degree-of-Freedom Systems, by C. P. Atkinson. (60—WA-26)
The Bending Stress Distribution at the Base of a Stationary Crack, by M. L. Williams. (60—APMW-14)
A Nondestructive Three-Dimensional Strain-Analysis Method, by A. J. Durelli and I. M. Daniel. (60—WA-16)
A New Approach to the Analysis of the Deflection of Thin Cantilevers, by R. Frisch-Fay. (60—WA-17)
Stresses and Deflections in an Elastically Restrained Circular Plate Under Hydrostatic Normal Pressure Over a Segment, by W. A. Bassali and N. O. M. Hanna. (60—WA-30)
The Elastic Plane With a Circular Insert, Loaded by a Radial Force, by J. Dundurs and M. Hetényi. (60—WA-202)
On the Buckling of Circular Cylindrical Shells Under Pure Bending, by Paul Seide and V. I. Weingarten. (60—WA-33)
On the Bending of Circular Cylindrical Shells by Equal and Equally Spaced End Radial Shear Forces and Moments, by Paul Seide. (60—WA-32)
Stress Distribution in a Rotating Spherical Shell of Arbitrary Thickness, by M. A. Goldberg, V. L. Salerno, and M. A. Sadowsky. (60—WA-19)

Brief Notes

Dynamic Similitude for Lead, W. G. Soper.
Stability of the Hinge Formed in an Ideal Rigid-Plastic Beam, M. J. Hillier.
Response of Nonlinearly Supported Cylindrical Boundaries to Shock Waves, M. L. Baron.
On the Behavior of Impact Tubes at Low Reynolds Numbers, W. R. Schowalter and G. E. Blaker.
Size Effect in Brittle Fracture of Notched E-Steel Plates in Tension, J. H. Ludley and D. C. Drucker.
On Duffing's Equation, I. U. Ojalvo and G. L. Bleckman.
A Note on Second-Order Hertz Contact, H. Deresiewicz.
Note on Bending of Rectangular Plates by Concentrated Couples on Its Edge, G. R. Verma.
On Some Systems of Equations Encountered in Thin Plate and Elasticity Theory, H. D. Conway.
On the Photoelastic Separation of Principal Stresses Under Dynamic Conditions by Oblique Incidence, P. D. Flynn and M. M. Frocht.
On Simple Thickness Vibrations of Thin Sandwich Cylinders, Hu-Nan Chu.
A Modified Energy Method for Determining Natural Frequencies, R. P. N. Jones.
Thermal Stress in a Plate Due to Disturbance of Uniform Heat Flow by a Hole of General Shape, H. Deresiewicz.

Discussion

Discussion of previously published papers by M. Hetényi; T. K. Caughey; K.-T. Yang, F. P. J. Rimrott, E. J. Mills, and Joseph Marin; F. P. J. Rimrott; H. G. Landau, J. H. Weiner, and E. E. Zwicky, Jr.; H. D. Conway; Paul Seide; F. R. E. Crossley and Üstün Germen; G. F. Carrier and J. W. Miles.

Book Reviews

Journal of Basic Engineering

The March, 1961, issue of the Transactions of the ASME—*Journal of Basic Engineering* (available at $1.50 per copy to ASME Members, $3 to nonmembers)—contains the following:

Minimum Toughness Requirements for High Strength Sheet Steel, by J. A. Kies, H. Romine, H. L. Smith, and H. Bernstein.
Energy Versus Stress Theories for Combined Stress—A Fatigue Experiment Using a Rotating Disk, by W. N. Findley, P. N. Mathur, E. Szczepanski, and A. O. Temel. (60—Met-1)
Microplastic Strain Hysteresis Energy as a Criterion for Fatigue Fracture, by C. E. Feltner and JoDean Morrow. (60—Met-2)
Crack Propagation in Thin Metal Sheet Under Repeated Loading, by H. W. Liu. (60—Met-11)
Fracture of Flat and Curved Aluminum Sheets With Stiffeners Parallel to the Crack, by J. Frisch. (60—Met-3)
A Study of Theories of Fracture Under Combined Stresses, by I. Cornet and R. C. Grassi. (60—Met-4)
Dynamic Synthesis of Higher-Order, Optimum Saturating Systems, by Fred Kurzweil, Jr. (60—JAC-2)
Solution Space Approach to Optimal Control Problems, by Yu-Chi Ho. (60—JAC-11)
The Optimum Response of Second-Order, Velocity-Controlled Systems With Contactor Control, by Irmgard Flügge-Lotz and Mih Yin. (60—JAC-3)
Pulse-Width Relay Control in Sampling Systems, by W. L. Nelson. (60—JAC-4)
Investigation of Periodic Modes of Sampled-Data Control Systems Containing a Saturating Element, by W. E. Merserve and H. C. Torng. (60—JAC-9)
Reduction of Dimensionality, Dynamic Programming, and Control Processes, by Richard Bellman and Robert Kalaba. (60—JAC-6)
Design of Optimum Multivariable Control Systems, by E. B. Lee. (60—JAC-5)
Kinetic Lyapunov Function for Stability Analysis of Nonlinear Control Systems, by S. S. L. Chang. (60—JAC-7)
New Results in Linear Filtering and Prediction Theory, by R. E. Kalman and R. S. Bucy. (60—JAC-12)
Approximate Method for Calculating the Time Response in Linear, Time-Varying, and Nonlinear Automatic Control Systems, by B. Naumov. (60—JAC-10)
Improvement of the Power Efficiency of a Hydraulic Control System by the Use of a Gain Compensated Control Valve, by S.-Y. Lee. (60—JAC-8)
Preliminary Design of a Roll-Stabilization System for a Ship, by D. V. Stallard. (60—JAC-1)

Includes Letters from Readers on Miscellaneous Subjects

COMMENTS ON PAPERS

Fresh Water From Salt Water

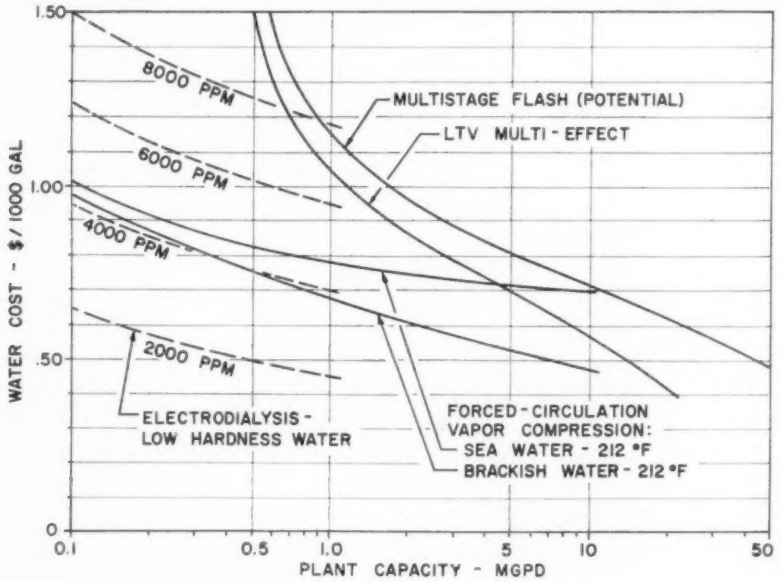
Comment by E. D. Howe[1] and J. T. Chambers[2]

THE author of this paper[3] is to be congratulated on his clear and concise explanation of the Demonstration Plant program and its background. Certainly, the statistical data relating water demand and supply in the future support his conclusion that demineralization probably will be needed. However, one has to temper this conclusion with the realization that different regions in the U. S. A. have different relations in water use between domestic, industrial, and irrigation applications. In California, for example, irrigation use represents 80 to 90 per cent of the demand, and costs which would render demineralized water usable for irrigation will be much lower than those permissible in industrial and domestic applications.

The long-tube-vertical construction seems to be interesting and the costs indicated in Fig. 5 are attractive. However, before drawing too many conclusions, it would be well to have clearly in mind the exact conditions for the data basic to this figure, such as the assumed cost of heat energy, the number of effects used, and the maximum temperature. One could well ask whether the "breakthrough" in scale control is such that brine temperatures in the evaporators are to be pushed up appreciably beyond the 250 F maximum.

Concerning the multiflash evaporation system, it would also be of interest to learn the bases for costs shown in Fig. 9. The indication is that costs are reduced as a result of increased plant capacity alone. Specification of other improvements—such as increased temperature in the highest stage, along with basic assumed conditions—also would complete the usefulness of this diagram. In this connection, Fig. 8 fails to demonstrate one major advantage of the multiflash system, the possibility of including many flashing stages in a single shell. The flow circuit can then be "straight through" on all streams—coolant, product, and flashing brine. Thus the expense and friction losses associated with headers and connecting piping is greatly reduced. These factors, together with the elimination of intermediate pumps and heat exchangers as mentioned by the author, can effect reduced capital expenditures for the multiflash scheme.

Graphical comparison of the cost estimates in Figs. 5, 9, 14, and 17 proves interesting and leads to several notable conclusions as indicated in the accompanying figure. The Long-Tube-Vertical (LTV) multieffect plant is indicated as having greater economy than the multistage flash plant in all plant capacities. For example, in capacities of 20 million gpd, water from flash plants is shown to be 50 per cent more expensive than that from the LTV process. There is also clear indication that forced-circulation vapor compression is more economical than both LTV plants up to 4 million gpd and flash plants up to ten million gpd capacities. Assuming a "salinity of influent" of 5000 ppm, the cost estimates for the electrodialysis plants are higher than estimates for distillation. As the author suggests, electrodialysis is a relatively newer method of water demineralization than the distillation processes, and further development can therefore be expected to reduce comparative water costs. However, since "future" developments are indicated as bringing the cost of operation on 5000 ppm water below that for distillation, specification of the necessary improvements for achieving this lower cost would seem desirable.



[1] Professor of mechanical engineering, director, Sea Water Conversion Laboratory (Richmond, Calif.), College of Engineering, University of California, Berkeley, Calif. Mem. ASME.

[2] Graduate research engineer, Sea Water Conversion Laboratory, University of California, Berkeley, Calif.

[3] Allen Cywin, "Fresh Water From Salt Water," MECHANICAL ENGINEERING, vol. 82, October, 1960, pp. 57–62.

A final point of particular interest, suggested by the graphical comparison in the figure, is the implication that vapor compression distillation of brackish waters, followed by blending of the product water, can be as economical as electrodialytic separation of 4000 ppm water. If the assumed salinity of the brackish water for vapor compression is 4000 ppm or greater, this conclusion is most significant. It is therefore essential to know the assumed salinity upon which the vapor compression curve is based. The author's comments on these observations are solicited. In particular, it would be most desirable to know the unstated assumptions of the various curves, and whether they will permit a valid comparison among the curves.

The costs cited in Fig. 12 for water produced from nuclear-driven flash distillation plants are most encouraging. Apparently, the projected cost for water at $102 per acre-ft in 1972 is based partially on the assumption of effective, inexpensive scale control techniques to allow evaporation up to 250 F, and on the assumption that a low-temperature nuclear reactor can supply steam at about 23 cents per million Btu. Since a steam cost of 55 cents per million Btu is recommended by the OSW as consistent with current costs from conventional fuel sources, the author's comments on the probability of achieving the 23 cents figure are invited.

As the author stresses, the water costs cited are estimates since in most cases no reliable cost figures are available from sizable plants now in operation. Firm cost figures will be a major contribution of the Demonstration Plant program. It is therefore desirable to have some clarification of the amount of experimentation to be provided for in the construction of the demonstration plants, and to know what effect this will have on the cost figures obtained.

The author's presentation of current cost estimates for the various demonstration processes included in the Demonstration Plant program will prove immensely helpful to those of us working in the field of water demineralization. It is only through repeated comparison of such figures that the progress of our work can be measured.

Author's Closure

Professors Howe and Chambers have had a long and intimate association with developments in saline water conversion. Their comments now afford an additional opportunity, not permitted by the length restriction of the original paper, to amplify on water costs.

The various types of consumer does of course vary from region to region. California may indeed be a largely agricultural water-consuming state. However, the entire state population (largely municipal in number) was recently asked to vote on a mammoth $1.75 billion general obligation bond issue for an additional water supply. All of the taxpayers will retire those bonds and thus the capital cost of the project will never be reflected by the water rates chargeable to water customers. This is not an unusual method of financing waterworks. Water rates are of course much higher when revenue bonds are used for new facilities.

Therefore it is well never to compare water costs unless they are computed on the same basis.

The cost curves in this paper[3] were computed by a standard procedure for comparing the cost of one process versus another and based upon the present state of technology for each system. For example, as Howe and Chambers note, the LTV costs were based on a 250 F top evaporating temperature whereas the flash system has only been successful to date up to 200 F. Operating at the same temperature might give a cost advantage to the flash process due to a fewer number of components (such as pumps) and through use of a "straight through" flow circuit as noted in Fig. 11 of the original paper.

The demonstration plants are therefore designed to develop a better appreciation of not only capital but maintenance and operating costs. The capital cost estimates for the one million gpd Texas and California plants as well as the 250,000 gpd South Dakota plant have since been confirmed by the award of lump-sum construction contracts based upon competitive bidding procedures.

Plants using distilling processes may, through blending, increase their output up to nearly 30 per cent (for 2000 ppm water) for a potable water supply. However, the electrodialysis process still appears to be slightly more economical for the lower salinity waters, especially in the smaller-sized plants.

As noted in Table 2, steam costs may vary from a combination power-plant cycle and thus further reduce process costs, although the capital cost of equipment still provides the largest area for process improvement. The low-cost nuclear process steam reactor providing large volumes of low-pressure steam for a base load cycle still remains to be developed.

It may be of interest to know that the Freeport demonstration plant is designed to permit 300 F operation. At that evaporating temperature, the same evaporating capacity (pumping would have to be increased) could produce 70 per cent more water. The San Diego plant could produce 30 per cent more water by increasing its evaporating temperature to 250 F. We plan to attempt such operation with new scale-control techniques.

Large capacity plants would certainly bring water-conversion costs to less than 50 cents per thousand gallons, which is competitive with many other new sources of supply.

It is therefore not too early to start to consider saline water conversion as a reliable source of good quality water in those regions where water supply is becoming a problem.

Allen Cywin.[4]

[4] Chief, Demonstration Plants Division, Office of Saline Water, U. S. Department of the Interior Washington, D. C. Mem. ASME.

BOOKS RECEIVED IN LIBRARY

ASM Review of Metal Literature, 1959

Edited by Marjorie R. Hyslop. 1960, American Society for Metals, Novelty, Ohio. 1266 p., 6¼ × 9¼ in., bound. $20. The 16th annual collation of the monthly annotated survey of articles, technical papers, and reports dealing with the technology of metals, appearing in engineering, scientific, and industrial journals and books here and abroad, prepared at the Center for Documentation and Communications Research, Western Reserve University, Cleveland.

Advances in Vacuum Science and Technology

(Proceedings of the First International Congress on Vacuum Techniques, June 10–13, 1958, Namur, Belgium) Edited by E. Thomas. 1960, Pergamon Press, Inc., New York, N. Y. Two volumes, 8¾ × 11¼ in., bound. $30. These two volumes contain the 156 papers presented at the Congress, covering the problems relating to scientific foundation of vacuum techniques, the means of obtaining and measuring high and ultrahigh vacuum, applications of vacuum techniques in pure and applied research, mainly the nuclear sciences and nuclear engineering, and applications in metallurgy, and in the chemical, pharmaceutical, plastics, electronics, optical, and food industries.

Analogue and Digital Computers

Edited by M. G. Say. 1960, Philosophical Library, Inc., New York, N. Y. 308 p., 5¾ × 9 in., bound. $15. A presentation of

LIBRARY SERVICES

Engineering Societies Library books, except bibliographies, handbooks, and other reference publications, may be borrowed by mail by ASME members for a small handling charge. The Library also prepares bibliographies, maintains search and translation services, and can supply a photoprint or a microfilm copy of any item in its collection. Address inquiries to R. H. Phelps, Director, Engineering Societies Library, 29 West 39th Street, New York 18, N. Y.

---

the basic material on the design and application of analog and digital computing systems for newcomers to the computer field, composed of chapters contributed by British specialists in the field.

Analysis and Design of Feedback Control Systems

By George J. Thaler and Robert G. Brown. Second Edition. 1960, McGraw-Hill Book Company, Inc., New York, N. Y. 648 p., $6^1/_4 \times 9^1/_4$ in., bound. $14.50. This is the second edition of a senior college text, "Servomechanism Analysis." Extensive alterations, including the change of title, result from integration of material in both design and analytic aspects of feedback control theory. Chapters 1 to 7 constitute a basic course in feedback controls, and 8 and 9 discuss design principles and their application. The remaining chapters cover Mitrovic's method for analysis and synthesis, sampled-data servo systems, phase-plane analysis of nonlinear servos, describing functions, and relay servomechanisms. The up-dated appendixes include the Nichols chart, and description of error detectors, controllers, servomotors, and compensating devices.

Applied Engineering Mechanics

By Alfred Jensen. Second Edition. 1960, McGraw-Hill Book Company, Inc., New York, N. Y. 409 p., $6^1/_4 \times 9^1/_4$ in., bound. $6.50. A simplified approach explaining the basic concepts of engineering mechanics and their application in the solution of a wide variety of engineering problems. Thoroughly revised, this edition includes new material on statics, including sections on belt friction, the forces produced by hydrostatic loads, and in suspension cables and arches, and the stability of retaining walls, and new material on dynamics, including expanded treatment of noncentroidal rotation, and sections on dynamic equilibrium of plane motion, direct central impact, conservation of linear momentum, and angular impulse-momentum relationships in rotation and plane-motion problems.

Atomkraft

By Friedrich Münzinger. 1960, Springer-Verlag, Berlin, Germany. 304 p., $6^1/_2 \times 9^1/_2$ in., bound. DM 42.00. An introduction to the problems involved in the construction of nuclear power plants. Intended for engineers, industrialists, and power economists, the first three sections deal with the theoretical fundamentals of nuclear energy, reactor technology including heat engines, and economic aspects of nuclear plants as power producers. A new chapter in the revised edition covers nuclear propulsion for ships, airplanes, etc.

Atomic Theory for Students of Metallurgy

By William Hume-Rothery. 1960, The Institute of Metals, London, England. 427 p., $5^3/_4 \times 8^3/_4$ in., bound. $7.50. The third edition of a monograph first published in 1946 for advanced metallurgy students, to describe the general ideas on which the electron theories of metals and alloys are based. No attempt is made to deal with mathematical technique. The six parts of the book deal with general background theories; the structure of the free atom; the nature of the interatomic forces involved in the formation of solids, liquids, and compound molecules; the free-electron theory of metals; the Brillouin-zone theory of metals; and finally specific metals are discussed from this standpoint. The crystal structure of the metallic elements is given in an appendix.

Chemical Processing Nomographs

Edited by Dale S. Davis. 1960, Chemical Publishing Company, Inc., New York, N. Y. 255 p., $6^1/_4 \times 9^1/_2$ in., bound. $12. For chemists and engineers engaged in research, operation, technical control, and sales in the chemical-processing industries, this is an edited and selected collection of 166 of the best of the 230 nomographs published during recent years in *Chemical Processing*. They are supplemented by brief explanatory material, simple working directions for constructing the most common type of alignment charts, and detailed subject and author indexes. The nomographs are grouped under such subject headings as heat, flow of fluids, pulp mill calculations, vapor pressures, v-p-t relationships, solubilities, densities and specific gravities, viscosities, relative humidity, costs, sizing of equipment, and conversions.

Davison's Textile Blue Book, 1960

Published 1960 by Davison Publishing Company, Ridgewood, N. J. 1366 p., $5^3/_4 \times 8^1/_4$ in., bound. $9.75. A directory of manufacturers, mills, dyers, finishers, sanforized licensees, dry goods dealers, designers, brokers, associations, schools, maps, machinery statistics, and related aspects of the textile field in the U. S. and Canada. The lists of mills, manufacturers, etc., are classified by product and subdivided geographically, and there are complete alphabetical indexes to mills, dyers, and raw cotton firms, including a separate index to raw cotton firms of the world. Also included is a buyer's guide to mill equipment, supplies and services, profuse advertising (often disruptive of the orderly lists), and an index to advertisers.

Decisions Under Uncertainty, Drilling Decision by Oil and Gas Operators

By C. Jackson Grayson, Jr., 1960, Division of Research, Harvard Business School, Soldiers Field, Boston, Mass. 402 p., $5^1/_2 \times 8^1/_2$ in., in., bound. $6. The first objective of this book is to describe problems in drilling for gas and oil—to drill or not to drill—and how businessmen actually make drilling decisions. The second objective is to explore the possibilities of the application of mathematical theories to such decisions. The methods suggested for this purpose are clear and simple, requiring only a working knowledge of arithmetic and high-school algebra.

Dictionary of Automatic Control

By Robert J. Bibbero. 1960, Reinhold Publishing Corporation, New York, N. Y. 282 p., $5^1/_4 \times 7^3/_4$ in., bound. $6. A unique feature of this book is an index arranged under the five major subject divisions the book covers—control theory and basic concepts; computers and data processing; industrial machine and process control; aircraft and missile control and telemetering; and control components and design features—which assists in the location of a particular term as in a thesaurus. In the main text the terms are dealt with alphabetically by means of a brief discussion rather then just a definition. Extensive cross-referencing permits discussion of related terms or concepts under one heading in a unified essay, rather then in alphabetically separated · explanations. The author has spent five years collecting, editing, and interpolating the material.

Diesel Engineering Handbook

By Karl W. Stinson. 10th Edition. 1959, Diesel Publications, Inc., Stamford, Conn. 383 p., $8^1/_2 \times 11^1/_2$ in., bound. $10. This completely rewritten edition features increased emphasis on basic engineering principles and the design and construction of modern diesel, dual-fuel and natural gas engines and their auxiliaries. Specific aspects are covered in detail, including performance, testing, fuels and fuel injection, engine components, lubrication, maintenance, and special systems for starting, exhaust, and the like. Appendixes contain description, illustration, and specifications of all types of diesel and gas engines obtainable in the United States.

Digital Computers and Nuclear Reactor Calculations

By Ward C. Sangren. 1960, John Wiley & Sons, Inc., New York, N. Y. 208 p., $6 \times 9^1/_4$ in., bound. $8.50. A primary objective of this book is to present to the nuclear engineer or scientist an introduction to high-speed nuclear-reactor calculations. One small reactor calculation is discussed thoroughly and a number of representative types of calculations is considered briefly. The first four chapters deal with an introduction to reactor problems, digital computers, programming, and numerical analysis, and the last four with considerations involved in actual reactor calculations.

Elementary Introduction to Nuclear Reactor Physics

By S. E. Liverhant. 1960, John Wiley & Sons, Inc., New York, N. Y. 447 p., $6^1/_4 \times 9^1/_4$ in., bound. $9.75. This textbook for undergraduates in physics and engineering is an elementary account of that branch of physics involved in the study and design of nuclear reactors. The first three chapters deal with fundamental aspects of nuclear physics directly related to the physics of nuclear reactors. The discussion then develops the concepts of the compound nucleus, neutron cross sections, and their relationship, and examines the physical aspects of nuclear fission, the interaction of neutrons with matter in bulk, and thermal and fission neutrons. Neutron diffusion theory then is considered, and the nonstationary reactor described and explained. The concluding chapters deal with the detection, measurement, and safeguards against nuclear reactor radiations.

Die Gaserzeuger

By Kurt Schmidt. Second Edition. 1959, Springer-Verlag, Vienna, Austria. 51 p., $7^1/_2 \times 10^1/_2$ in., paper. $3.55. This study on gas-producers is vol. 1, part 2, of "Die Verbrennungskraftmaschine," edited by Hans List. It presents a theoretical introduction to gas as an engine propellant and a discussion of gas production from solid fuels: Coking, gasification and gas conduction. The two final chapters deal with gas generators in practice and with the selection of the proper size.

Heat Transfer and Fluid Mechanics Institute—Proceedings, 1960

Published 1960 by the Stanford University Press, Stanford, Calif. 259 p., $6^3/_4 \times 10$ in., bound. $8.75. This volume contains 18 papers reporting completed investigations presented at the 13th meeting of the Institute, all American save for one from England and one from Belgium. The papers deal with research in vortex motion, boundary-layer flows, origins of turbulence, flows not in thermodynamic equilibrium, separated flows, two-phase flow systems, and thermal radiation problems in space technology.

How to Chart Data

By Phil Carroll. 1960, McGraw-Hill Book Company, Inc., New York, N. Y. 260 p., $6^1/_4 \times 9^1/_4$ in., bound. $7.50. Here are discussed the type of data required in the solution of various management problems in areas of work measurement, plant scheduling and control of costs, and the ways of presenting them in easy-to-analyze forms. Six different chart forms are dealt with in detail, their development shown in progressive illustrations, and the general conditions for their use pointed up.

IP Standards for Petroleum and Its Products, Part 4: Methods for Sampling

Published 1960 by the Institute of Petroleum, London, England. 44 p., $5^1/_2 \times 8^1/_2$ in., paper. No price given. Beginning with 1960, the Institute's "Standard methods for testing petroleum and its products" will be issued in four separate sections: Methods for analysis and testing; methods for rating fuels —engine tests; methods for assessing performance of crankcase lubricating oils—engine tests; and methods for sampling. Part 4 is the first to be received, and is a revised version of IP No. 51. The sampling techniques and apparatus described are technically equivalent to those in the ASTM 1957 manual. Minor differences in terminology persist through reluctance to change established nomenclature.

Industrial Architecture

By James F. Nunce. 1960, F. W. Dodge Corporation, New York, N. Y. 232 p., $9^1/_2 \times 12^1/_2$ in., bound. $14.75. This book is an attempt to capture the essence of the modern factory. Particular emphasis has been placed on current practice in the U. S., Great Britain, and Germany. The four major types of industry—heavy, light, utility, and process—are analyzed in terms of the various ways in which the units for each are enclosed, serviced, and operated. Also included is a study of industrial parks, estates, and districts. The text is amply illustrated by photographs, line drawings, and sketches.

International Missile and Spacecraft Guide

By Frederick I. Ordway, III, and Ronald C. Wakeford. 1960, McGraw-Hill Book Company, Inc., New York, N. Y. Various pagings, $9 \times 11^1/_4$ in., bound. $25. This is a handbook on specific missile systems, with emphasis on American missiles, due to greater availability of information in the place of publication. It analyzes individual missiles of each country and relates given systems to other similar systems and to a general class of military or research vehicle. Illustrated descriptions and available technical specifications, from unclassified sources of information only, are given for the major guided and unguided missiles. Facts only are given for existing types, but informed fancy is indulged in sections covering future evolution. A key feature is inclusion of missiles that never reached the manufacturing stage, providing little-known but useful information. Another feature is the "chronology of missile progress," with its extensive performance data tables, and "organization of missile authorities," arranged by nation and listing names and addresses of government agencies, industrial firms, research organizations, universities, associations, and the like active in the missile field.

Kinematics and Dynamics of Machinery

By Robert L. Maxwell. 1960, Prentice-Hall, Inc., Englewood Cliffs, N. J. 477 p., $6^1/_4 \times 9^1/_4$ in., bound. $9.75. This text was developed for use in undergraduate machine-design courses. The first ten chapters discuss kinematics, emphasizing acceleration analysis, comparing various methods of kinematic analysis, and demonstrating its role in the complete dynamic analysis of mechanisms. The next nine chapters cover static force analysis, and dynamic analysis, involving kinematic analysis as a tool, and covering in detail the speeds and static and dynamic balancing of rotating and reciprocating members, and forces imposed by gyroscopic effects. The final three chapters discuss cams, gearing, and gear trains, using the principles of kinematics and dynamics in the process.

Land for the Future

By Marion Clawson and others. 1960, The Johns Hopkins Press, Homewood, Baltimore, Md. 570 p., $6^1/_4 \times 9^1/_4$ in., bound. $8.50. A study made under the auspices of Resources for the Future, Inc., a nonprofit corporation for research and education in the development, conservation, and use of natural resources, of changing uses of land in the U. S., in the past, the present, and in the light of expectations extending to the year 2000. Most of the book is of general, albeit absorbing, interest, discussing the methodology of the study, and describing the present and the historical situation and future projects. There are, however, chapters dealing with specific uses of land, of which those dealing with urban uses and planning, and uses for transportation, water regulation, mineral production, and possibly forestry which are pertinent to the engineering profession.

Long-Term Trends and Problems of the European Steel Industry

Published 1959 by the United Nations Economic Commission for Europe, Geneva, Switzerland. Distributed by the Columbia University Press, New York, N. Y. 176 p., $8^1/_2 \times 11$ in., paper. $2. Based on an extensive study begun in 1956, this publication examines world consumption and production of steel, and of steel-making raw materials, the economic consequences of technical trends, past and future, and assesses trends to 1975. The final three chapters assess the steel future in relation specifically to European activity and requirements, discussing possible solutions to some of the problems raised by the study, and indicating the nature of others. ECE cautions that the conclusions reached here are purely arbitrary, and that all long-range forecasts need to be examined periodically, and more closely detailed for application in specific regions, but add that the comprehensive statistics here assembled should be universally useful.

Management of Nuclear Materials

Edited by Ralph F. Lumb. 1960, D. Van Nostrand Company, Inc., Princeton, N. J. 516 p., $6^1/_4 \times 9^1/_4$ in., bound. $16.50. The purpose of this book is to accumulate in one place the basic philosophies and practices developed by the AEC and its contractors for maintaining control over nuclear materials. It will be of interest to organizations having to control either nuclear materials or nonnuclear materials of somewhat similar, unique characteristics. Discussion is restricted to control of uranium and plutonium as exemplifying procedures for all nuclear materials. It also covers general background materials as well as detailed information conveyed by means of case histories. The complete chain of operations is described, from the procurement and processing of uranium ore, through refinement of uranium, separation of isotopes, fabrication of reactor fuel elements and their use in reactors, and recovery and utilization of plutonium as well as scrap and irradiated fuel recovery and the material control aspects of research and development activities.

Motion and Time Study

By Marvin E. Mundel. Third Edition. 1960, Prentice-Hall, Inc., Englewood Cliffs, N. J. 690 p., $6^1/_4 \times 9^1/_4$ in., bound. $11.95. This edition reflects the extensive industrial applications made during the past five years, and includes new topics on work sampling and sampling standards, motion economy, statistical analysis and mathematical models, verified by first-hand observation in this and other countries. This is a practical book, presenting the basic principles of successful work and developing them through detailed description and extensive illustration from a wide variety of industry and types of work into the final time-and-motion study procedures.

Noise Reduction

Edited by Leo L. Beranek. 1960, McGraw-Hill Book Company, Inc., New York, N. Y. 752 p., $6^1/_4 \times 9^1/_4$ in., bound. $14.50. This volume was developed from lectures given by various authorities at four special summer programs from 1953–1960 conducted by M.I.T. on the subject of noise reduction in industry. The introduction takes the form of a literature survey and bibliography on the historical background. Intended to be readable by graduate engineers in nearly any technical field, the material is organized in four sections—sound waves and their measurement; fundamentals underlying noise control; criteria for noise and vibration control; practical noise control.

Precision Measurement and Gaging Techniques

By William Grohe. 1960, Chemical Publishing Company, Inc., New York, N. Y. 222 p., $5^3/_4 \times 8^3/_4$ in.. bound. $7.50. The primary purpose of this book is to acquaint the technical and engineering student with up-to-date instruments, methods, and techniques used in inspection and gaging. The author discusses screw, unified and American National Taper threads from the standpoint of accuracy checks, and describes ramp and fixed gages, precision gage blocks, and pneumatic gaging. Other topics covered include mechanical and electronic comparators, optical measuring instruments, measurements with light waves, evaluation of surface roughness, hardness testing, torque wrenches, and the use of the slide rule.

Rarefied Gas Dynamics

Edited by F. M. Devienne. 1960, Pergamon Press, Inc., New York, N. Y. 442 p., $6^1/_4 \times 9^1/_4$ in., bound. $17.50. This first symposium on gas dynamics held at Nice in 1958, resulted in 29 papers, six of them in French, which are published here. Several papers deal with the basic theory, kinetic theory, and aerodynamics of rarefied gases, the latter including slip-flow considerations, hypersonic

aspects, and the continuum theory. Other papers examine the Boltzmann equation, the measurement of rarefied gases, the use of wind tunnels in aerodynamic research, free molecule flow, and plasma dynamics. The papers reflect wide range of interest but present selective rather than exhaustive investigation of the whole field.

Reactor Analysis

By Robert V. Meghreblian and David K. Holmes. 1960, McGraw-Hill Book Company, Inc., New York, N. Y. 808 p., $6^1/_4 \times 9^1/_4$ in., bound. $19.50. This graduate college text is a mathematical development of reactor analysis—the mathematical study of the nuclear behavior of reactors based on certain approximate physical models. Familiarity with advanced calculus partial differential equations, boundary-value problems, and the fundamentals of modern physics and methods of engineering analysis is assumed. The majority of the reactor analyses presented are given in detail, using mathematical models selected for their prime suitability in describing the various neutron phenomena, and are extended to the derivation of working formulas illustrated by numerical examples displaying computational techniques. Formal presentation only is supplied for those few methods of which it is desired solely to exhibit the principal physical ideas.

1959 References on Fatigue

Published as Special Technical Publication No. 9-K by the American Society for Testing Materials, Philadelphia, Pa. 88 p., $8^1/_2 \times 11$ in., paper. $4. This is a list of references published in 1959 dealing with the fatigue of structures and materials. Brief abstracts are included where available, and the references are arranged so that the sheets may be cut apart for filing as desired. This is the tenth volume in the series, which covers references published 1950 to 1959.

Repertorium und Ubungsbuch der Technischen Mechanik

By István Szabó. 1960, Springer-Verlag, Berlin, Germany. 373 p., $6^1/_2 \times 9^1/_2$ in., bound. DM 24.00. Through a great number of examples this basic text aims to provide the engineering student with a basic knowledge of technical mechanics. Each new section is preceded by a theoretical résumé and by the appropriate formulas. The contents include such topics as the statics of rigid bodies, stress analysis and deformation, the theory of elastic structures, kinematics and kinetics, liquid and gas dynamics, etc.

The Role of Nuclear Propulsion in Merchant Shipping

Edited by G. Edwin Brown, Jr., and William J. Smith. 1960, Atomic Industrial Forum, Inc., New York, N. Y. 172 p., $8^1/_4 \times 11$ in., paper. $7.50. The proceedings of the April, 1960, meeting sponsored by the Atomic Industrial Forum, presenting papers and discussions on economic potentials for nuclear merchant ships, safety and liability problems, propulsion systems, plans of shipbuilders and operators, and activities in the field abroad.

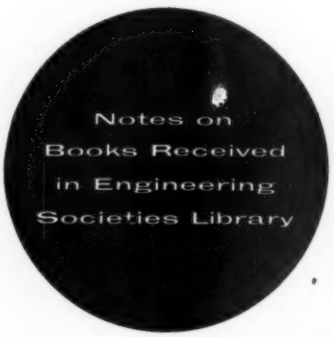
Soil Engineering

By Merlin Grant Spangler. Second Edition. 1960, International Textbook Company, Scranton, Pa. 483 p., $6^1/_4 \times 9^1/_4$ in., bound. No price given. With a notable foreword by Karl Terzaghi, this is a practical introduction of the subject on the undergraduate level. It describes the origin, properties, and classification of soils; all aspects of water, frost, and stress distribution in soil; and soil practice in connection with dams and levees, retaining walls, underground conduits, piles, and pile-driving; and the consolidation and settlement of structures. This new edition incorporates improvements and additions reflecting advances in the science since 1951.

Stresses in Shells

By Wilhelm Flügge. 1960, Springer-Verlag, Berlin, Germany. 499 p., $6^1/_2 \times 9^1/_2$ in., bound. DM 58.80. Written for practising engineers and research workers, this book contains a unified presentation of the basic facts of shell theory, and solutions in sufficient detail to make them readily applicable to design work. The level of the mathematical tools employed has been kept as low as compatible with the needs of the subject matter. Familiarity with linear differential equations is necessary and with partial differential equations would be useful. Chapter one contains introductory matter, chapters 2–4 cover membrane theory, chapters 5–6 are devoted to the bending theory of the circular cylinder and the general shell of revolution, and the final chapter is concerned with the stability of shells.

The Appendix contains a compilation of formulas concerning forces and deformations in circular rings.



REVIEWS OF BOOKS

Kinematic Geometry of Gear Teeth

Introduction to the Kinematic Geometry of Gear Teeth

By Allan H. Candee. Chilton Co., Philadelphia, Pa., 1961. Cloth $6 \times 9^1/_4$ in., preface, references, figs., appendix, tables, index, ix and 204 pp., $12.50.

Reviewed by Jesse Huckert[1]

A STOREHOUSE of toothed-gear definitions, principles, and motion-transfer concepts is united with practical methods of gear-tooth geometry by this book. Although the work bears the word *Introduction* in the title, it is an elaborate treatise on the tooth generation and tooth design of spur gears. It is complete by itself, being preliminary or introductory in the sense that the geometrical principles and methods carry forward into the design of teeth on other types of gears.

Constructions by the methods of plane geometry are copious. Trigonometry is used sparingly and the equations of curves, infrequently. All curves are plane and the most complex curves are the involute of a circle and the cardioid, which are defined mechanically and geometrically rather than analytically. Centers of curvature, instant centers, and systems of rectangular co-ordinates are used often.

Much use is made of diagrams and relationships that define the differences between small distances and angles, not in terms of large dimensions like center distance and radii of curvature, but rather in terms of small changes and variations of these larger dimensions. This procedure achieves not only simple formulas, but also relationships among quantities of comparable magnitudes, all of which are numerically small. Acceptable gear-design accuracy is possible from short arithmetical calculations.

Eleven chapters comprise the text and figures. The headings of chapters 3, 5, 8, 10, and 11 are representative; viz., Cutting and Generating Spur Gears; Fillet Curves; Changes in Center Distance in Involute Gears; Profile Errors, Modifications, Variations; and Involute Approximations. One of the approximations is that of the involute by the cardioid. The explanation of the method of matching the cardioid to the involute of the circle to an extremely close degree, and the descriptions of two simple mechanisms to true a grinding wheel closely to a specified involute arc, are published for the first time in this book.

Six tables of involute co-ordinates related to the author's idea of "involute triangles" are contained in the Appendix. The convenience and application of the tables are illustrated as part of the text by problems such as the profile layout of a tooth on a large gear, the profile layout of a pinion tooth to an enlarged scale, and the comparison of an arc of an involute with arcs of a circle, a parabola, and a cardioid.

[1] Associate editor, *Machine Design*, Cleveland, Ohio. Fellow ASME.

ASME BOILER AND PRESSURE VESSEL CODE

Interpretations

THE Boiler and Pressure Vessel Committee meets regularly to consider "Cases" where users have found difficulty in interpreting the Code. These pass through the following procedure: (1) Inquiries are submitted by letter to the Secretary of the Boiler and Pressure Vessel Committee, ASME, 29 West 39th St., New York 18, N. Y.; (2) Copies are distributed to Committee members for study; (3) At the next Committee meeting interpretations are formulated to be submitted to the ASME Board on Codes and Standards, authorized by the Council of the Society to pass upon them; (4) They are submitted to the Board for action; (5) Those which are approved are sent to the inquirers and are published in MECHANICAL ENGINEERING.

(The following Case Interpretations were formulated at the Committee meeting Jan. 1, 1961, and approved by the Board March 6, 1961.)

Annulment of Cases

Reason for Annulment
Case 1239

Provisions of Case included in December 15, 1960, Addenda to Section VIII

Case 1270N-3

(Special Ruling)

General Requirements for Nuclear Vessels

Revise as follows:

Par. 3(b) of the Reply in the third line delete "and those vessels defined in 5(c)." In seventh line revise reference to 1272N-1 to read 1273N-4.

Case 1273N-5

(Special Ruling)

Nuclear Reactor Vessels and Primary Vessels

Figure I of the Reply:
Add Fig. 1A Trepanned Nozzle.

Case 1297

(Special Ruling)

Use of Quenched and Tempered Alloy Steel Plates

Inquiry: Is it permissible in welded construction conforming to the requirements of Section VIII of the Code to use quenched and tempered steel plate and forgings conforming to the requirements of the following specifications?

(1) Scope. This specification covers alloy steel plates, up to 1 in. in thickness, of firebox quality and alloy steel forgings intended particularly for use in welded pressure vessels.

(2) General Conditions for Delivery. Material furnished under this specification shall conform to the applicable requirements of the current edition of the Tentative Specification for General Requirements for Delivery of Rolled Steel Plates of Flange and Firebox Qualities (ASTM Designation: A20) except as herein modified.

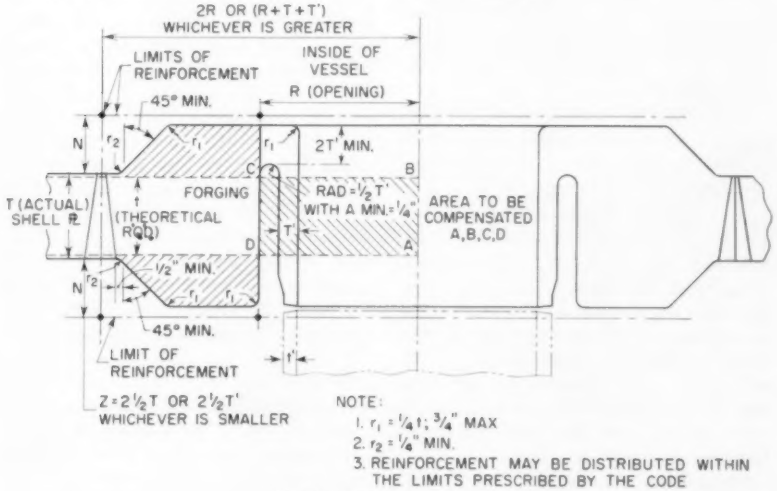


Fig. 1A Trepanned Nozzle

(3) Process. The steel shall be made by either or both of the following processes: Open Hearth or Electric Furnace.

(4) Heat Treatment. The material shall be treated by the material manufacturer to produce the tensile requirements of Table II by heating to not less than 1650 F, quenching in water between 50 and 100 F, and tempering to not less than 1150 F with a holding time of one hr per in. of thickness but in no case less than one half hr.

(5) Chemical Composition. The steel shall conform to the chemical requirements prescribed in Table I. If the material is subjected to check analysis, the AISI standard permissible variations apply.

Table I Chemical Requirements

	Per Cent
Carbon	0.15/0.200
Manganese	0.80/1.100
Phosphorus, max	0.035
Sulphur, max	0.040
Silicon	0.50/0.800
Chromium	0.50/0.800
Molybdenum	0.18/0.280
Zirconium	0.05/0.150

(6) Tensile Properties. The material as represented by the tension test specimens shall conform to the requirements as to tensile properties prescribed in Table II.

Table 2 Tensile Requirements

Tensile Strength, psi	115,000 to 135,000
Yield Strength, psi, min	100,000
Elongation in 2 in./min per cent	18

(7) Bending Properties. The bend test specimen shall stand being bent cold (room temperature) through 180 deg without cracking on the outside of the bent portion to an inside diameter which shall have the relation to the thickness of the specimen prescribed in Table III. When the test is made on a specimen reduced in thickness, the rolled surface shall be on the outer surface of the bend.

Table 3 Bend Diameters

Thickness of Material	Ratio of Bend Diameters to Thickness of Specimen
1 in. and under	2

(8) Test Specimens. The test specimens shall be prepared from the material in its heat-treated condition, or from full

thickness samples similarly and simultaneously treated.

(9) Number of tests for Plates. One tension test longitudinal from the bottom, one tension test longitudinal from the top and one bend test transverse from the top shall be made from each plate as heat treated. One homogeneity test shall be made from each plate as rolled.

Note: The term "plate as rolled" used here refers to the unit plate rolled from a slab or directly from an ingot in its relation to the location and number of specimens, not to its condition.

(10) Number of tests for Forgings and Formed Parts. One tension and one bend specimen shall be made of each heat of material included in any one heat-treatment lot.

Reply: It is the opinion of the Committee that the material specified in the inquiry may be used in the construction of welded pressure vessels under the rules of Section VIII of the Code provided the following additional requirements are complied with.

(1) The minimum thickness of shells, heads and other pressure containing parts shall be $^1/_4$ in. and the maximum thickness shall be 1 in.

(2) The maximum operating temperature shall not exceed 150 F.

(3) The requirements of Par. UG-84 shall be met for vessels that are to operate at temperatures below −20 F.

(4) The maximum allowable stress value shall be 28,750 psi.

(5) Shell plates shall not be heated for forming to a temperature higher than 1100 F. Other parts including heads that are heated for forming to temperatures over 1100 F shall be heat treated by the manufacturer of the head or part. Forgings shall be heat-treated by the manufacturer of the forging. Test specimens prepared from full-thickness material in its final heat treated condition, or from full-thickness samples primarily and simultaneously treated, shall be taken from any pressure parts that have been heat treated above 1100 F after forming.

(6) When the shell or head thickness exceeds 0.58 in., the finished vessel shall be stress-relieved as provided in Par. UCS-56(c). The stress-relieving temperature shall be between 1000 and 1100 F using the holding periods specified in Footnote no. 1 to Par. UCS-56.

Cautionary Note: Filler metal deposited by nickel-molybdenum-vanadium type of electrodes can become embrittled at the above stress-relieving temperatures.

(7) Double welded butt-joints or their equivalent shall be examined radiographically for their full length as prescribed in Par. UW-51. (See Item 18 of the Reply.)

(8) Welds not fully radiographed, including welds for attaching nonpressure parts, shall be examined after the hydrostatic tests by the magnetic-particle method.

(9) The qualification of the welding procedure and the welders shall conform to the requirements of Section IX, except that the radius of the mandrel used in the guided bend tests shall be as follows:

Thickness of Specimen	Radius of Mandrel (B)*	Radius of Die (D)*
$^3/_8$ in.	$1^1/_4$ in.	$1^{11}/_{16}$ in.
t	$3^1/_8$ t	$4^1/_8$ t + $^1/_{16}$ in.

* Corresponds to dimensions B and D in Figs. Q-8 and QN-8, Section IX; other dimensions to be in proportion.

A separate welding procedure qualification test shall be made for this material. Due consideration shall be given to heat input during welding as the properties of the base metal may be adversely affected if this is excessive.

(10) All main welded joints including welds for nozzle attachment shall be of the double-welded butt type or their equivalent. Where a backing strip is used, it shall be removed and the joint shall be examined by the magnetic-particle method prior to the required full radiographing. All openings regardless of size shall meet the requirements for reinforcing.

(11) All parts shall be made of the material specified in the Inquiry, except that pipe flanges or pipe of carbon steel may be welded to nozzle necks of the material specified in the Inquiry provided the butt weld is located more than a distance equal to the square root of $r \times t$ measured from the face of the reinforcement, where r = the inside radius of the nozzle neck and t = the thickness of the nozzle at the surface of the vessel or reinforcing plate if one is used. The design of the nozzle neck shall be made on the basis of the allowable stress value of the weaker material.

(12) Structural attachments and Stiffening rings of other steels shall not be welded directly to shells or heads of material specified in the Inquiry.

(13) Conical sections shall be provided with a skirt having a length not less than $0.50\sqrt{rt}$ (where r is the inside radius of the adjacent cylinder and t is the thickness of the cone), or $1^1/_2$ in., whichever is larger. A knuckle shall be provided between the skirt and the cone; the knuckle radius shall be not less than 6 per cent of the outside diameter of the skirt but in no case less than three times the cone thickness.

(14) The longitudinal joint misalignment shall not exceed 20 per cent of the nominal plate thickness, or $^3/_{32}$ in., whichever is less, instead of the values prescribed in Par. UW-33.

(15) The circumferential joint-alignment tolerances shall be as follows, instead of the values prescribed in Par. UW-34:

For plates up to and including $^3/_4$ in. in thickness	20% of nominal plate thickness
For plates over $^3/_4$ in. and up to and including 1 in. in thickness	$^3/_{16}$ in.

(16) When repairs have to be made to welded joints, the repair procedure shall be qualified in accordance with the original welding procedure, subject to the stipulations that thermal cutting and gouging processes to be employed in the repair work shall be included as part of this procedure qualification.

Cautionary Note: The properties of the base metal may be adversely affected by excessive local heat inputs.

(17) When hemispherical heads are used, the head-to-shell transition of Fig. UW-9, sketch (c), shall be used. When the weld is in or adjacent to the tapered section it shall be finished in a manner that will maintain the required uniform slope for the full length of the tapered section.

(18) The requirements of Pars. UW-35(a) and UW-51(b) shall be met except that the maximum finished weld reinforcement shall not exceed 10 per cent of the plate thickness, or $^1/_8$ in., whichever is less. (This joint surface finish is necessary for this material to minimize strain intensification, in addition to providing for satisfactory radiographs.)

(19) Welds for pads, lifting lugs, and other nonpressure parts, as well as temporary lugs for alignment, shall be made in full compliance with a welding procedure qualified in accordance with Section IX. Temporary welds shall be removed, the area shall be inspected for damage, and the metal surface shall be restored to a smooth contour. If repair welding is required, it shall be qualified in accordance with Item (16) of the Reply.

(20) Steel stamping of all types may be omitted on plates below $^1/_2$ in. thickness. Other markings used in lieu of stamping to identify material shall be legible on the completed vessel until final acceptance by the authorized inspector.

Case 1298

Quenched and Tempered Steel

Inquiry: Is it permissible in welded construction conforming to the requirements of Section VIII of the Code to use quenched and tempered steel plates and

forgings conforming to the requirements of the following specifications?

(1) Scope. This specification covers alloy steel plates of firebox quality intended particularly for use in welded pressure vessels.

(2) General Conditions for Delivery. Material furnished under this specification shall conform to the applicable requirements of the current edition of the Tentative Specification for General Requirements for Delivery of Rolled Steel Plates of Flange and Firebox Qualities (ASTM Designation: A20) except as herein modified.

(3) Process. The steel shall be made by either or both of the following processes: Basic Open Hearth or Basic Electric Furnace.

(4) Heat Treatment. The material shall be treated by the material manufacturer to produce the tensile requirements of Table 2 by heating to not less than 1650 F, quenching in water or oil, and tempering to not less than 1150 F.

(5) Chemical Composition. The steel shall conform to the chemical requirements prescribed in Table 1.

If the material is subjected to check analysis, the AISI standard permissible variations apply.

Table 1 Chemical Requirements

	Per Cent
Carbon	0.12/0.2000
Manganese	0.40/0.7000
Phosphorus, max	0.0350
Sulphur, max	0.0400
Silicon	0.20/0.3500
Chromium	1.40/2.0000
Molybdenum	0.40/0.6000
Titanium	0.04/0.1000
Vanadium	*
Copper	0.20/0.4000
Boron	0.0015/0.0050

* May be substituted for part or all of titanium content.

(6) Tensile Properties. The material as represented by the tension test specimens shall conform to the requirements as to tensile properties prescribed in Table 2.

Table 2 Tensile Requirements

Tensile Strength, psi	115,000 to 135,000
Yield strength, psi, min	100,000
Elongation in 2 in./min, per cent	18

(7) Bending Properties. The bend test specimen shall stand being bent cold (room temperature) through 180 degrees without cracking on the outside of the bent portion to an inside diameter which shall have the relation to the thickness of the specimen prescribed in Table 3. When the test is made on a specimen reduced in thickness, the rolled surface shall be on the outer curve of the bend.

Table 3 Bend Diameters

Thickness of Material	Ratio of Bend Diameters to Thickness of Specimen
1 in. and under	2
Over 1 in. to 2 in., incl.	3

(8) Test Specimens. The test specimens shall be prepared from the material in its heat-treated condition, or from full-thickness samples similarly and simultaneously treated.

(9) Number of Tests for Plates. One tension test longitudinal from the bottom, one tension test longitudinal from the top and one bend test transverse from the top shall be made from each plate as heat treated. One homogeneity test shall be made from each plate as rolled.

Note: The term "plate as rolled" used here refers to the unit plate rolled from a slab or directly from an ingot in its relation to the location and number of specimens, not to its condition.

(10) Number of Tests for Forgings and Formed Parts. One tension and one bend specimen shall be made of each heat of material included in any one heat-treatment lot.

Reply: It is the opinion of the Committee that the material specified in the inquiry may be used in the construction of welded pressure vessels under the rules of Section VIII of the Code provided the following additional requirements are complied with:

(1) The minimum thickness of shells, heads and other pressure containing parts shall be $\frac{1}{4}$ in. The maximum thickness of the shell and head plates shall be 2 in.

(2) The maximum operating temperature shall not exceed 650 F.

(3) The requirements of Par. UG-84 shall be met for vessels that are to operate at temperatures below −20 F.

(4) The maximum allowable stress values shall be:

For Metal Temperatures Not Exceeding Deg F						
−20 to 150	200	300	400	500	600	650
28750	27750	26750	26000	25875	25750	25000

(5) Shell plates shall not be heated for forming to a temperature higher than 1100 F. Other parts including heads that are heated for forming to temperatures over 1100 F shall be heat-treated by the manufacturer of the head or part. Forgings shall be heat-treated by the manufacturer of the forging. Test specimens prepared from full-thickness samples similarly and simultaneously treated shall be taken from any pressure parts that have been heat-treated above 1100 F after forming.

(6) When the shell or head thickness exceeds 0.58 in., the finished vessel shall be stress-relieved as provided in Par. UCS-56(c). The stress-relieving temperature shall be between 1000 and 1100 F using the holding periods specified in Footnote 1 to paragraph UCS-56.

Cautionary Note: Filler metal deposited by nickel-molybdenum-vanadium type of electrode can become embrittled at the above stress relieving temperature.

(7) Double welded butt-joints or their equivalent shall be examined radiographically for their full length as prescribed in Par. UW-51. (See Item 18 of the Reply.)

(8) Welds not fully radiographed, including welds for attaching nonpressure parts, shall be examined after the hydrostatic tests by the magnetic-particle method.

(9) The qualification of the welding procedure and the welders shall conform to the requirements of Section IX, except that the radius of the mandrel used in the guided bend tests shall be as follows:

Thickness of Specimen	Radius of Mandrel (B)*	Radius of Die (D)*
$\frac{5}{8}$ in.	$1\frac{1}{4}$ in.	$1\frac{11}{16}$ in.
t	$3\frac{1}{8}$ t	$4\frac{1}{8}$ t + $\frac{1}{16}$ in.

* Corresponds to dimensions B and D in Figs. Q-8 and QN-8, Section IX; other dimensions to be in proportion.

A seperate welding procedure qualification test shall be made for this material.

(10) All main welded joints including welds for nozzle attachment shall be the double-welded butt type or their equivalent. Where a backing strip is used, it shall be removed and the joint shall be examined by the magnetic-particle method prior to the required full radiographing. All openings regardless of size shall meet the requirements for reinforcing.

(11) All parts shall be made of the material specified in the Inquiry, except that pipe flanges or pipe of carbon steel may be welded to nozzle necks of the material specified in the inquiry provided the buttweld is located more than a distance equal to the square root of r × t measured from the face of the reinforcement, where r = the inside radius of the nozzle neck and t = the thickness of the nozzle at the surface of the vessel or reinforcing plate if one is used. The design of the nozzle neck shall be made on the basis of the allowable stress value of the weaker material.

(12) Structural attachments and stiffening rings of other steels shall not be welded directly to shells or heads of material specified in the Inquiry.

(13) Conical sections shall be provided with a skirt having a length not less than $0.50\sqrt{rt}$ (where r is the inside radius of the adjacent cylinder and t is

the thickness of the cone), or 1 1/2 in., whichever is larger. A knuckle shall be provided between the skirt and the cone; the knuckle radius shall be not less than 6 per cent of the outside diameter of the skirt but in no case less than three times the cone thickness.

(14) The longitudinal joint misalignment shall not exceed 20 per cent of the nominal plate thickness, or 3/32 in., whichever is less, instead of the values prescribed in Par. UW-33.

(15) The circumferential joint-alignment tolerances shall be as follows, instead of the values prescribed in Par. UW-34:

For plates up to and including 3/4 in. in thickness	20 per cent of nominal plate thickness
For plates over 3/4 in. and up to and including 1 1/2 in. in thickness	3/16 in.
For plates over 1 1/2 in. in thickness	12 1/2 per cent of nominal plate thickness but not to exceed 1/4 in.

(16) When repairs have to be made to welded joints, the repair procedure shall be qualified in accordance with the original welding procedure, subject to the stipulation that thermal cutting and gouging processes to be employed in the repair work shall be included as part of this procedure qualification.

Cautionary Note: The properties of the base metal may be adversely affected by excessive local heat inputs.

(17) When hemispherical heads are used, the head-to-shell transition of Fig. UW-9, sketch (c), shall be used. When the weld is in or adjacent to the tapered section it shall be finished in a manner that will maintain the required uniform slope for the full length of the tapered section.

(18) The requirements of Pars. UW-35(a) and UW-51(b) shall be met except that the maximum finished weld reinforcement shall not exceed 10 per cent of the plate thickness, or 1/8 in., whichever is less. (This joint surface finish is necessary for this material to minimize strain intensification, in addition to providing for satisfactory radiographs.)

(19) Welds for pads, lifting lugs, and other nonpressure parts, as well as temporary lugs for alignment, shall be made in full compliance with a welding procedure qualified in accordance with Section IX. Temporary welds shall be removed, the area shall be inspected for damage, and the metal surface shall be restored to a smooth contour. If repair welding is required, it shall be qualified in accordance with Item (16) of the Reply.

(20) Steel stamping of all types may be omitted on plates below 1/2 in. thickness. Other markings used in lieu of stamping to identify material shall be legible on the completed vessel until final acceptance by the authorized inspector.

Case 1299

(Special Ruling)

Copper-Nickel-Iron Alloy Tubes

Inquiry: May tubes of a copper-nickel-iron alloy in the annealed temper with chemical composition as follows

Copper, min, per cent	60.0*
Nickel, per cent	29.0 to 33.0
Iron, per cent	4.75 to 5.75
Manganese, max, per cent	1.0
Zinc, max, per cent	1.0
Lead, max, per cent	0.05

* Copper plus sum of named elements shall be 99.5 per cent min.

and with mechanical properties as follows

Tensile strength, min, psi	74,000
Yield strength (0.5 per cent extension under load), min, psi	36,000
Elongation, per cent in 2 in., min	30
Expansion of tube inside diameter with tapered pin, per cent, min	30

and otherwise conforming with the requirements for annealed-temper 70–30 copper-nickel alloy in Specification SB-111, be used in ASME Boiler and Pressure Vessel Code construction?

Reply: It is the opinion of the Committee that copper-nickel-iron alloy tubes in the annealed temper, as described in the Inquiry, may be used for ASME Boiler and Pressure Vessel Code construction.

The maximum allowable stress values to be used in the design formulas where reference is made to Table UNF-23 are as follows:

Temperature, F	Allowable Stress Values, psi
100	18,300
150	17,800
200	17,500
250	17,100
300	16,800
350	16,400
400	16,100
450	15,900
500	15 600
550	15,400
600	15,200

Case 1300

(Special Ruling)

Copper-Nickel-Iron Alloy Tubes in annealed or a Drawn, Stress Relieved Temper

Inquiry: May tubes of copper-nickel-iron alloy in an annealed or a drawn, stress-relieved temper with chemical composition as follows

Copper, min, per cent	52.5*
Nickel, per cent	40.0 to 43.0
Iron, per cent	1.5 to 2.5
Manganese, per cent	0.8 to 1.7
Zinc, max, per cent	0.3
Lead, max, per cent	0.05

* Copper plus nickel, iron and manganese, 99.5 per cent min.

and with mechanical properties as follows

	Temper	
	Annealed	Drawn Stress-relieved
Tensile strength, min, psi	64,000	85,000
Yield strength (0.5 per cent extension under load), min, psi	28,000	65,000
Elongation, per cent in 2 in., min		
for wall thicknesses up to 0.048 in., incl	30	12
for wall thicknesses over 0.048 in.	30	15
Expansion of tube inside diameter with tapered pin, per cent, min	30	20
Average grain size, mm	0.010–0.045	..

and otherwise conforming with the requirements for annealed or "drawn stress relieved" temper of 70–30 copper-nickel alloy in Specification SB-111, be used in ASME Boiler and Pressure Vessel Code construction?

Reply: It is the opinion of the Committee that copper-nickel-iron alloy tubes in the annealed or drawn, stress-relieved tempers as described in the Inquiry, may be used for ASME Boiler and Pressure Vessel Code construction.

The maximum allowable stress values to be used in the design formulas where reference is made to Table UNF-23 are as follows:

Temperature, F	Allowable Stress Values, psi	
	Annealed	Drawn, stress-relieved
100	15,800	21,000
150	15,200	20,500
200	14,900	19,800
250	14,600	19,200
300	14,400	18,800
350	14,000	18,500
400	13,800	18,200
450	13,700	17,900
500	13,500	17,600
550	13,400	17,500
600	13,200	17 500
650	13 100	17,500
700	12,800	17,500
750	12,500	17,100
800	12,300	16,600

Case 1301

(Special Ruling)

Alternate Method of Bend Testing Procedure and Performance Qualification Coupons

Inquiry: Is it permissible in Section IX to test specimens for procedure or per-

formance qualification in a fixture wherein one end of the bend test specimen is fixed, and the specimen is bent around a mandrel of the required radius by means of an outer roller? This type fixture would be an alternate to the guided bend test jig shown in Figs. Q-8, QN-8, QB-8, Q-8.1, QN-8.1 and QB-8.1 of ASME Section IX.

Reply: It is the opinion of the Committee that the intent of the Code is met by a bend test wherein one end of the bend test coupon is fixed and the specimen is wrapped around a mandrel of the proper diameter by means of an outer roller. Such a jig may be used for testing weld joints of ferrous and non-ferrous materials or between dissimilar alloys having different strengths. In making these bends the following conditions shall be met:

CONDITION:

1 Jig dimensions shall conform to Fig. 1. of this case. Dimensions not shown are the option of the designer. The essential consideration is to have adequate rigidity so that the jig parts will not spring.

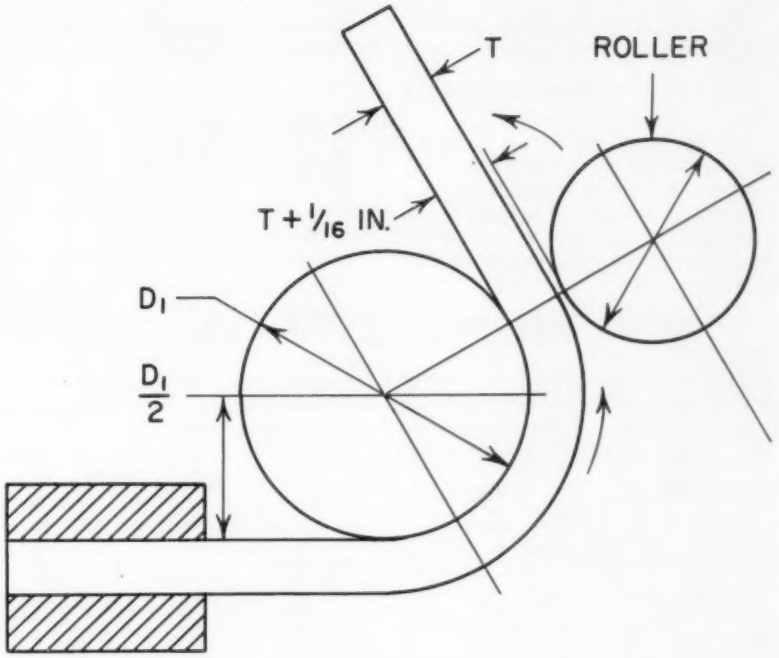
2 The specimen shall be firmly clamped on one end so that there is no sliding of the specimen during the bending operation. The weld and heat affected zone in the case of transverse weld bend specimens shall be completely within the bent portion of the specimen after testing.

3 Test specimens shall conform to the dimensions shown on Figs. Q-7.1, QN-7.1(a), QN-7.1(b), Q-7.2, QN-7.2, Q-7.3, QN-7.3, QB-7.2, QB-7.3.

4 Test specimens shall be removed from the jig when the outer roll has been moved 180 deg from the starting point.

TEST ACCEPTANCE:

1 The bends to be acceptable shall meet the applicable requirements of Paragraphs Q-8, QN-8 or QB-8.



DIMENSIONAL REQUIREMENTS

SPECIM. THICK. T	D_1
3/8 IN.	1 1/2 IN.
1/8 IN.*	2 1/8 IN.
T	4 T
3/8 IN.**	2 1/2 IN.

*NOTE: THE THICKNESS OF SPECIMEN OF 1/8 IN. SHOULD BE USED ONLY FOR MATERIALS IN GROUP P-23 AND SB-171 ALLOY E IN GROUP P-35 IN TABLE QN-11.1.

**NOTE: THE THICKNESS OF THE 3/8 IN. THICK SPECIMEN WITH A DIMENSION D_1 OF 2 1/2 IN. IS LIMITED TO THE USE OF P-25 MATERIAL.

Fig. 1

Proposed Revisions and Addenda to Boiler and Pressure Vessel Code . . .

As NEED arises, the Boiler and Pressure Vessel Committee entertains suggestions for revising its Code. Revisions approved by the Committee are published here as proposed addenda to the Code to invite criticism. If and as finally approved by the ASME Board on Codes and Standards, and formally adopted by the Council, they are printed in the semi-annual addenda supplements to the Code. Triennially the addenda are incorporated into a new edition of the Code.

In the following the paragraph numbers indicate where the proposed revisions would apply in the various sections of the Code.

Power Boilers, 1959

PREAMBLE Revise the second paragraph to read:

This Code covers rules for construction of power boilers to be used in stationary service, locomotive, portable and traction boilers.

PAR. P-22(f) Delete the words "internal or."

FIG. P-32(f) Add "T" dimension (tube sheet thickness). Also revise note referring to depth of recess to read: Not more than T/3 nor less than t or 1/8 in. whichever is the greater.

FIG. P-32(g) Revise note referring to tube projection to read: Max t.

TABLE P-3 In the title delete the words "water tube or."

TABLE P-7 Delete Grade C of Specification SA-203 and its stress values.

PAR. P-116 Revise the first sentence to read:

All piping external to the boiler installed under the provisions of PAR. P-112 shall be installed by a manufacturer or contractor authorized to use any of the symbols shown in Fig. P-41 and Fig. P-49 or the "S" Symbol shown in Fig. P-48.

PAR. P-250(a)(1) Revise the third sentence to read:

The depth of any bevel or recess shall not be less than the tube thickness or $^1/_8$ in. whichever is the greater nor more than $^1/_3$ of the tube sheet thickness.

PAR. P-291(b) Add the following:

Boilers of locomotives shall have at least one water glass provided with top and bottom shutoff cocks and lamp, and two gage cocks for boilers 36 in. in diameter and under, and three gage cocks for boilers over 36 in. in diam.

The lowest gage cock and the lowest reading of water glass shall be not less than 2 in. above the highest point of crown sheet on boilers 36 in. in diameter and under, nor less than 3 in. for boilers over 36 in. in diameter. These are minimum dimensions, and on large locomotives and those operating on steep grades, the height should be increased, if necessary, to compensate for change of water level on descending grades.

The bottom mounting for water glass and for water column if used must extend not less than $1^1/_2$ in. inside the boiler and beyond any obstacle immediately above it, and the passage therein must be straight and horizontal.

Tubular water glasses must be equipped with a protecting shield.

FIG. P-48 Revise the wording in the title, "official symbol for stamp" to read: "official symbols for stamps."

Also, add the facsimile of the "L" symbol.

PAR. P-332(c) Revise the first part of this sentence to read:

Permission to use a power boiler or locomotive boiler symbol stamp shown in FIG. P-48, . . .

FORM P-2 In item 4 delete Roman Numeral III.

Unfired Pressure Vessels, 1959

PAR. UG-40(d) (1) Revise to read:

Metal in the vessel wall over and above the thickness required to resist pressure and the thickness specified as corrosion allowance. The area of the vessel wall available as reinforcement is the larger of the values of A given by the formulas

$$A_1 = (E_1 t - t_r)d$$

or

$$A_1 = (E_1 t - t_r)(t + t_n)2$$

PAR. UG-40(d)(2) Designate present PAR. to read UG-40(d)(3) and add a new PAR. UG-40(d)(2) to read:

Metal over and above the thickness required to resist pressure and the thickness specified as corrosion allowance in that part of a nozzle wall extending outside the vessel wall. The maximum area in the nozzle wall available as reinforcement is the smaller of the values of A_2 given by the formulas

$$A_2 = (t_n - t_{rn})\,5t$$

or

$$A_2 = (t_n - t_{rn})(5t_n + 2p)$$

All metal in the nozzle wall extending inside the vessel wall may be included after proper deduction for corrosion allowance on all the exposed surface is made. No allowance shall be taken for the fact that a differential pressure on an inwardly extending nozzle may cause opposing stress to that of the stress in the shell around the opening.

Where

A_1 = area in excess thickness in the vessel wall available for reinforcement, sq in. (See Fig. UA-280 and Par. UG-40);

A_2 = area in excess thickness in the nozzle wall available for reinforcement, sq in. (See Fig. UA-280 and Par. UG-40);

E = 1 when an opening is in the plate or when the opening passes through a circumferential joint in a shell or cone (exclusive of head-to-shell joints);

or

E_1 = The joint efficiency obtained from Table UW-12 when any part of the opening passes through any other welded joint;

p = thickness of reinforcing pad, in.;

t = nominal thickness of the vessel wall, less corrosion allowance, in.;

t_r = required thickness of a seamless shell or head as defined in Par. UG-37, ins.;

t_n = nominal thickness of nozzle wall, less corrosion allowance, ins.;

t_{rn} = required thickness of a seamless nozzle wall, ins.;

d = diameter in the plane under consideration of the finished opening in its corroded condition, in. (See Par. UG-37(b)).

PAR. UG-41(a) At end of PAR. add:

"Deposited weld metal used as reinforcement shall be credited with an allowable stress value equivalent to the weaker of the materials connected by the weld."

PAR. UG-46(c) In first line after the word vessels add: over 12 in.

PAR. UG-46(d) Revise to read:

"For vessels 12 in. or less in inside diameter, openings for inspection only may be omitted if there are at least two removable pipe connections not less than $^3/_4$ in. pipe size."

PAR. UG-46(e) In first line after the word vessels add: over 12 in. but.

PAR. UW-12(c) Add at the end of the Par.

". . . except for stresses S_a, S_b, S_f and S_s used in flange design and defined in Table UA-51."

TABLE UCS-23 Under Plate Steels, low alloy steels, delete Spec. SA-203 Grade C and its stress values.

Under Forgings, low alloy steels SA-372 V (A & B) add Grade E to the Grades A & B shown.

Under Explanation of Note 24 add Grade E to Grade V (A & B) shown.

TABLE UCS-27 Table UCS-27 in the June 10, 1960, addenda correct SA-243 to read: SA-423.

TABLE UNF-23 Aluminum and Aluminum Alloy Products. Under sheet and plate delete Spec. SB-209 GM41A O Temper 38000 Tensile in its entirety. Under SB-209 GM40A H112 Revise Note 11 to read Note 10. Under Explanation of footnotes, delete present footnote (10) and designate footnote (11) as (10).

PAR. UA-280

Revised Paragraph available from the Secretary of the ASME Boiler and Pressure Vessel Committee, 29 West 39th Street, New York 18, N. Y.

FIG. UA-280

Available from the Secretary of the ASME Boiler and Pressure Vessel Committee, 29 West 39th Street, New York 18, N. Y.

FIG. UA-280.5

Revised Figure available from the Secretary of the ASME Boiler and Pressure Vessel Committee, 29 West 39th Street, New York 18, N. Y.

Current Engineering Events, News, and Comment

E. S. NEWMAN
News Editor

THE ROUNDUP

EJC 1960 Study Reveals Engineers' Salaries Continue to Rise

In "Professional Income of Engineers—1960," fourth in a series of surveys conducted and published by the Engineering Manpower Commission on behalf of Engineers Joint Council, is revealed the good news that engineers' salaries continued to rise during 1959–1960. The over-all median for all engineering graduates for 1960 was $9600.

Summary of Engineering Income Data

Years of Experience	All	Industry	Education	Government
1	6725	6775	5375	6275
5	8100	8200	7350	7175
10	9875	9975	9100	8750
15	11000	11250	10950	9075
28	12450	12575	12575	10650

The survey representing some 200,000 engineers in industry, government, and education gives basic salary information for engineering graduates in the United States. Salaries are analyzed on the basis of years since baccalaureate degree because data are most readily available in this form, and because there is, as yet, no adequate classification of job responsibility commonly accepted in the profession which could be used as a base.

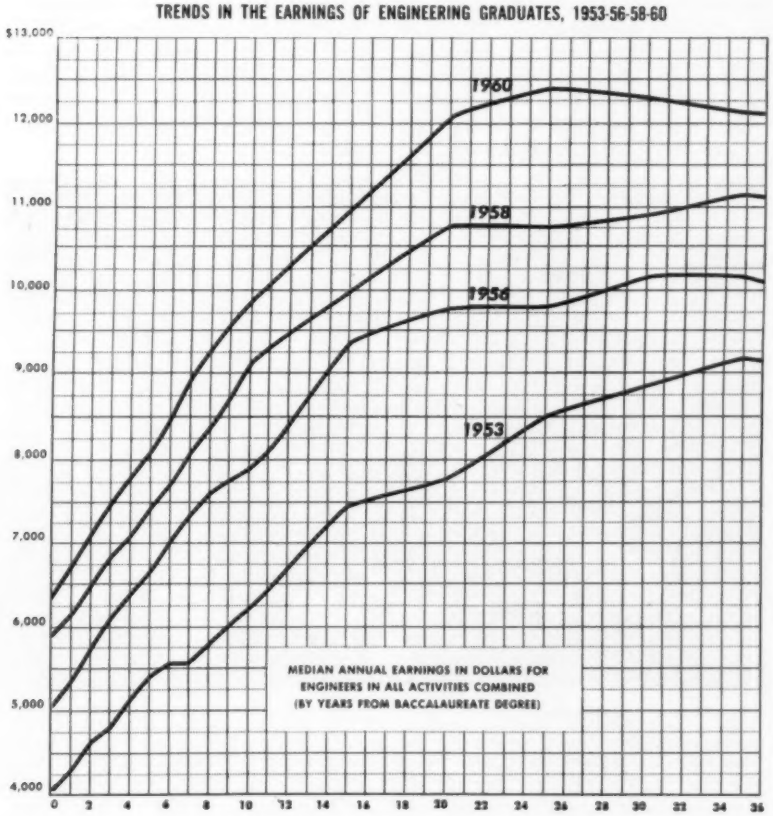
The purpose of this report is to show the present level of engineering salaries and, in addition, to indicate their trend over the past seven years. The samples in each survey are not exactly comparable because of changes in the participating group, particularly the decreased number of Federal Government participants in this survey compared with the 1958 survey. (See Mechanical Engineering, vol. 81, February, 1959, pp. 114–115.)

The 1960 median figure for the entire group of engineering graduates covered may be used to represent present salaries and this median compared with those in previous surveys may be used to determine the rate of change.

Median Salaries and Years of Experience in the Four Surveys

Year	Median Salary	Median Years of Experience	Annual Increase in Median Salary Over Previous Survey Actual	Adjusted
1960	$9600	9.8	4.8%	4.8%
1958	8750	9.8	6.4%	5.2%
1956	7750	9.1	6.4%	7.9%
1953	6500	10.2	...	...

TRENDS IN THE EARNINGS OF ENGINEERING GRADUATES, 1953-56-58-60



Questionnaires were mailed during late June and early July of 1960 to a basic list of about 1625 engineering employers in industry and government. Altogether, 597 companies and 133 government agencies replied to the questionnaire.

Usable data were received for a total of 185,148 engineering graduates employed in industry and government. This is purported to constitute one of the largest representative samplings of engineers ever studied in the U. S. in regard to salary information.

Breakdown of Number of Engineers in Survey Sample

	All Degrees	MS	PhD and ScD
Industry	164,657	18,862	4443
Government			
Federal	8,652	386	47
State (Highway Commission)	10,601	341	7
Local	1,238	74	3

The report is available from the Engineering Manpower Commission, EJC, 29 West 39th Street, New York 18, N. Y., at $3 a copy (slightly lower in bulk).

PEOPLE

Petroleum Paper to Be Given in England. ALLEN F. RHODES, Mem. ASME, vice-president of engineering and manufacturing of the McEvoy Company, Houston, Texas, has been requested to present a paper relative to pressure-energized high-pressure gaskets at the International Conference on Fluid Sealing of the British Hydromechanics Research Association in Ashford, Kent, England, April 17. The paper, which deals with the application of high-pressure gaskets to petroleum production equipment, was prepared by Mr. Rhodes and ROBERT EICHENBERG, Mem. ASME, chief engineer of McEvoy Company, which manufactures oil-well equipment. Mr. Rhodes is chairman of the ASME Petroleum Division. He was requested through ASME to present the paper as a representative of the entire oil industry.

New Officers. WARREN H. CHASE, vice-president of the Ohio Bell Telephone Company, Cleveland, was nominated for president of the American Institute of Electrical Engineers for 1961–1962 at the society's winter general meeting at the Hotel Statler-Hilton in New York. Among those also nominated as vice-presidents was THOMAS E. MARBURGER, Mem. ASME, assistant general superintendent, Baltimore Gas and Electric Company, Baltimore, Md.

BRIAN G. ROBBINS, Mem. ASME, has announced his retirement from the post of secretary of The Institution of Mechanical Engineers (Great Britain). KENNETH H. PLATT, deputy secretary, has been named to succeed him.

Campus Data. NATHAN MARCUVITZ, who has been director of the Microwave Research Institute at Polytechnic Institute of Brooklyn since 1957, has been appointed vice-president for research at Polytechnic. In his new position, Dr. Marcuvitz will direct research projects totaling more than $3,500,000 in annual expenditures.

Died. PAUL WOOTON, founder, in 1947, of the Society of Business Magazine Editors (of which ASME is a member), died in Washington, D. C., on February 16. He was Washington correspondent for The New Orleans Times-Picayune since 1914. In addition to his newspaper work, Mr. Wooton also represented the McGraw-Hill Publishing Company's periodicals, was a member of the editorial board of Chilton Publications, and correspondent for *Dun's Review* and *Modern Industry*.

W. H. Larkin Joins ASME Staff April 1

WILLIAM HARRISON LARKIN, who until recently was the New England manager for The Air Preheater Corporation, joined the staff of ASME on April 1, 1961, as assistant secretary in charge of Technological Services and the ASME Honors program. He will continue working with the Sections of the Society until the ASME Member Gifts Campaign for the new United Engineering Center is successfully completed.

He had been associated with Air Preheater since 1950. Previously, he was market analyst for Shell Petroleum Corporation, and also power-plant specialist for the B. F. Sturtevant Company in New York.

He received his engineering degree from Harvard University in 1925; a BS in (M.E.) and Business Administration; and an MBA from the Harvard School of Business Administration in 1933.

He is a past-president of the National Council of State Boards of Engineering Examiners. He served for ten and a half years on the New York State Board of Examiners for PE and LS.

Mr. Larkin is a life member of ASME and has been active in its affairs for the past 20 years. On April 1 he concludes 16 months as a Director on the Council. He also has served on the National Admissions Committee, the Board on Membership, the Board on Education, and is on the Finance Committee.

For the past five years he has been one of the ASME representatives on the Engineers' Council for Professional Development, was on the Executive Committee, was chairman of the Finance Committee, and of the Nominating Committee.

W. H. Larkin joins ASME Staff

Among his other activities he was president of the Harvard Engineering Society in 1948–1950 and serves on the Committee to visit the Division of Engineering and Applied Physics at Harvard.

He is a member of ASEE, the Newcomen Society of North America, and an Honorary Member (Cooper Union) of Pi Tau Sigma and served as president of the New York State Society of Professional Engineers, 1947–1948, and on the Board of Directors of NSPE. He is a registered engineer in New York, New Jersey, and Massachusetts.

Honors conferred at the Stevens Alumni annual dinner. Wendel W. Clinedinst, **left,** Mem. ASME, receives Stevens Alumni award for outstanding loyalty to the alumni association. J. H. Davis, **third from left,** Mem. ASME, president of the Stevens Institute of Technology, presents Stevens honor award for achievement in electrical engineering to Donald C. Luce, president of Public Service Electric and Gas Company, while William H. Byrne, **right,** President and Fellow ASME, looks on, having received the honor award for his achievements in engineering on the same occasion. The dinner was held in New York City on February 24.

MEETINGS OF OTHER SOCIETIES

• IN THE UNITED STATES

April 5–7

ASTM, symposium on materials and electron device processing, Benjamin Franklin Hotel, Philadelphia, Pa.

April 11–13

American Society of Lubrication Engineers, annual meeting, Bellevue-Stratford Hotel, Philadelphia, Pa.

April 17–21

American Welding Society, 42nd annual meeting and welding show, Commodore Hotel and the New York Coliseum, New York, N. Y.

April 19

Welding Research Council, University Research Committee annual conference, Hotel Commodore, New York, N. Y.

April 19–21

Institute of Radio Engineers, 13th annual southwestern conference and electronics show (SWIRECO), Baker Hotel and Dallas Memorial Coliseum, Dallas, Texas.

April 24–26

Association of Iron and Steel Engineers, meeting, Jefferson Hotel, St. Louis, Mo.

April 24–28

The American University, Sixth Institute on Research Administration, Washington, D. C.

April 26–28

Society of Plastics Industry, 18th annual Western Conference, Hotel del Coronado, Coronado, Calif.

May 1–2

Association of Records Executives and Administrators, fourth annual conference, Hotel Roosevelt, New York, N. Y.

May 2–4

Sixteenth Purdue Industrial Waste Conference, Purdue Memorial Center, Lafayette, Ind.

May 7–10

AIChE, national meeting, Sheraton-Cleveland Hotel, Cleveland, Ohio.

May 9–11

The Material Handling Institute, eastern states show and conference, Trade and Conventional Center, Philadelphia, Pa.

May 9–11

National Joint Computer Committee, western joint computer conference, Ambassador Hotel, Los Angeles, Calif.

May 10–12

Pulp and Paper Instrumentation Symposium, sponsored by the Instrument Society of America and TAPPI, Northland Hotel, Green Bay, Wis.

May 10–12

Society for Experimental Stress Analysis, Spring Meeting, Benjamin Franklin Hotel, Philadelphia, Pa.

May 11–13

American Institute of Industrial Engineers, 12th annual national conference and convention, Sheraton Cadillac Hotel, Detroit, Mich.

May 15–16

Society of American Military Engineers, national convention, Mayflower Hotel, Washington, D. C.

• IN EUROPE

April 17–19

International Meeting on Fluid Sealing, sponsored by the British Hydromechanics Research Association, Grosvenor Hall, Ashford, Kent, England.

April 19–21

Twenty-seventh joint congress of heating, ventilating, and air-conditioning, Hamburg, Germany.

May 2–9

Sixth international packaging exhibition, organized by N. V.'t Raedthuys, to be held in the R. A. I. exhibition halls, Amsterdam, The Netherlands.

May 3–4

Institution of Civil Engineers, railway modernization conference, London, England.

May 15–19

The Institute of Fuel, conference on waste heat recovery from industrial furnaces, Bournemouth, England.

June 9–17

European Convention of Chemical Engineering and ACHEMA 1961, Frankfurt am Main, Germany.

June 20–24

Fourth International Powder Metallurgy Congress, Reutte, Tyrol, Austria.

June 26–July 1

Second International Measurement Conference (IMEKO), Engineering Societies Building, and separately organized international measurement conference, Budapest, Hungary.

July 30–August 6

International Synposium on the Durability of Concrete, prepared by the Czechoslovak Academy of Sciences, Institute of Theoretical and Applied Mechanics, within the framework of The Permanent Committee of Rénuion Internationale des Laboratoires d'Essais et de Recherches sur les Matériaux et les Constructions (RILEM); to be held in Prague.

August 21–31

United Nations Conference on New Sources of Energy; and an industrial-commercial exhibition of equipment showing developments in solar, wind, and geothermal energy fields, organized by Rassegna Internazionale Elettronica, both in Rome, Italy.

August 23–26

Institute of Management Sciences, eighth annual international meeting. Palais des Congres, Brussels, Belgium.

• IN CANADA

April 17–19

Canadian Institute of Mining and Metallurgy, annual meeting, Chateau Frontenac Hotel, Quebec City, Quebec.

October 19–November 7

The Iron and Steel Institute, special meeting in the U. S. and Canada.

• IN JAPAN

November 6–11

Society of Chemical Engineers, Japan, 25th anniversary congress exhibition, Sankei Hall, Tokyo, Japan.

(*For ASME Coming Events, see page 127.*)

INDUSTRIAL FILMS

Jet Aircraft Engine

"The Constant Search," 16-mm sound and color film, tells the story of the first industrial power application of a stationary jet aircraft engine, the RT-248 jet gas turbine, which was developed for a southern natural-gas compressor station and now pumps 600 million cu ft of natural gas a day northward (see "Briefing the Record," MECHANICAL ENGINEERING, vol. 82, January, 1961, page 46). The movie follows the turbine's development from design to installation and operation, showing it in action as it develops 10,500 rotative hp.

The Columbia Gas System made the film available to technical schools, colleges, and adult groups through Modern Talking Picture Service in the area served by the gas system. This includes Kentucky, Maryland, New York, Ohio, Pennsylvania, Virginia, West Virginia, and Washington, D. C. Requests sent to Modern's office, 3 East 54th Street, New York 22, N. Y., will be forwarded to the proper library.

Conveyers

"Ideal Transport Story" shows all phases of construction and operation of the world's longest transport belt conveyer, a $5\frac{1}{2}$-mile-long Link-Belt system that carries limestone and shale from the Ideal Cement Company's quarry to its plant. The first major conveyer installation supported by prestressed concrete structures, the system is composed of seven separate belt conveyers arranged to feed consecutively one upon the other. The film, which was named the best sales promotion film of 1960 by *Industrial Photography Magazine*, may be borrowed

(*Continued on next page*)

United Engineering Center

The new United Engineering Center as it looked on February 27

The Ten Leading Sections

THE TEN sections sending in the largest total to the UEC project for the four months ending January 27 are: Boston, $3226; Chicago, $3092; Fairfield, $2758; San Francisco, $1395; St. Louis, $825; Philadelphia, $764; Greenville, $730; New Mexico, $668; Western Washington, $580; and Pittsburgh, $559.

The Greenville achievement is noteworthy because they advanced from 42 4 per cent of quota to 76.5 per cent, while boosting their member participation from 29.3 to 43.1. Chicago has just come in with another $1000 which will be included in the March report. Can Boston keep pace and retain their position at the head of the pack?

The responsibility for the success of the UEC local fund raising rests squarely on the shoulders of the Section Executive Committee. This fact of life was appreciated early by the Sections in Region V, aided and abetted by Ernie Allardt, and the result has been a successful campaign.

Each section may delegate to one individual the authority to organize and conduct the campaign, but it can never duck the responsibility for the results. This fact may not always have been appreciated.

It is axiomatic that the first qualification a canvasser must satisfy is to make his own gift. The same applies to all members of a Section Executive Committee and their team of activity chairmen. The first step that must be taken in this ASME cleanup effort is for every Section Executive Committee to get behind this UEC campaign by subscribing to it 100 per cent.

free on letterhead request for showing only in the U. S. A. from Link-Belt Company, Dept. PR, Prudential Plaza, Chicago 1, Ill.

Arc Welding

"Industrial Gases and Shielded Arc-Welding," a 27-min production issued by the Air Reduction Sales Company, features recently developed welding equipment and techniques. The 16-mm color and sound film correlates the story of industrial gases—oxygen, nitrogen, hydrogen, argon, and carbon dioxide—with welding applications. The major portion of the film illustrates the uses of these gases in Heliweld, Aircospot, and Aircomatic equipment. Through the eye of the ultra-high-speed camera, multiple-high-speed weldments and cutting operations are reproduced. Also shown are examples of economical and automatic production in the automotive field with Aircomatic equipment; fusion welds on aluminum with Heliweld and precise weldments on one side; and all-position work with Aircospot equipment. Prints may be obtained on loan without charge by contacting the local Airco representatives.

Lathe operators are instructed in running new machine by training film that bears recorded narration by their foreman in this scene from "Movies at Work," a 14-min informational film produced by Eastman Kodak Company. Such training films save the supervisor's time and reduce "down time" on costly machines for instruction purposes, as well as teaching safety methods or machine operations to employees, pinpointing trouble spots in machine operations through the use of slow-motion studies, or determining efficient use of plant space through the utilization of time-lapse films for traffic studies. These and other examples of how motion pictures can serve industry are illustrated in this 16-mm sound and color film, available without charge for individual showing from Audio-Visual Service, Eastman Kodak Company, Rochester 4, N. Y.

Notes on Society Activities and Events

E. S. NEWMAN
News Editor

THE ASME NEWS

ASME Summer Annual Meeting Program, Los Angeles, June 11–14, an Extravaganza

THE Los Angeles Section of the ASME will be the Host Section to the 1961 Summer Annual Meeting, June 11–14, at the Statler Hilton, Los Angeles, Calif. A well-rounded and diversified group of technical sessions, social events, and tours to major industries is being planned to make this an extremely worthwhile and pleasant meeting for members and their guests.

Technical Program. A highly informative and interesting technical program has been planned—thirty-seven technical sessions sponsored by 15 Professional Divisions, at which a number of papers will be presented. Among the subjects to which the sessions will be devoted are: Automatic controls, fuels, heat transfer, human factors, machine design, management, materials handling, nuclear engineering, petroleum, process industries, production engineering, and solar energy. Four sessions are planned to cover safety, including its practice in the fields of petroleum and aviation. Two sessions will be devoted to the Student Member Competition. One session, sponsored by the National Junior Committee, has for its subject, "The Young Engineer in Space."

Feature Events. Following the initial registrations on Sunday afternoon, the Los Angeles Section will be hosts at an "Early Bird" reception where members and guests will be invited to meet the other early arrivals and their friends in Los Angeles.

The high light of the Monday program will be the President's Luncheon, with an address by ASME President William H. Byrne. This will be followed in the afternoon by a special business meeting at 4:45 p.m. Special Division Luncheons are being planned by the Management Division for Tuesday and Petroleum Division for Wednesday.

The banquet will be held Tuesday evening following a Social Hour sponsored by the Los Angeles Section.

Plant Trips. Plant trips will be centered around the aviation and electronics industries. A trip to one of the larger Edison steam stations also is being considered. Details on the postmeeting tour to Mexico City appear in this issue.

The Women. A most interesting program for the women is being planned by Mrs. Ray Madison and her Co-Chairmen—Mrs. Joseph Widmont, Jr., and Mrs. William Winn. This will include the theater, luncheons, tours of the city, a TV studio, Disneyland, and Marineland.

Open Hearings for ASME National Nominations

THE 1961 Nominating Committee is to meet June 12–13, 1961, at the Statler-Hilton Hotel in Los Angeles, Calif., during the ASME Summer Annual Meeting. The Nominating Committee has scheduled open hearings so that members may speak in behalf of candidates for the following offices:

President—1962–1963
Vice-Presidents for Regions I, III, V, VII, IX, and XI 1962–1964
Three Directors—1962–1966
One Director—1962–1964

The schedule of these meetings will be:

Monday, June 12	9:00 a.m. to 12:00 noon 1:30 p.m. to 4:45 p.m.
Tuesday, June 13	8:30 a.m. to 12:00 noon

Southwesterly view from above Los Angeles shows Civic buildings and the downtown area. Statler Hilton will be headquarters for 1961 ASME Summer Annual Meeting, June 11–14.

The American Society of Mechanical Engineers

Mexico Post-Summer Annual Meeting Tour

Departing Los Angeles, June 15, 1961

THIS year, ASME is planning an exciting addition to our Summer Annual Meeting program. Why not take your vacation at Summer Annual Meeting time and join us on a wonderful trip to Mexico . . . it's just a hop away from Los Angeles. We will leave Los Angeles by swift Comet 4 Jet on June 15, and be in Mexico City a few hours later. From there you will choose between a seven-day program in cosmopolitan Mexico and a ten-day program which adds four nights in tropical Acapulco, the Riviera of the Western Hemisphere. In Mexico City we stay at the elegant Continental Hilton, located on the fashionable and convenient Paseo de la Reforma. The first night we start off with a gala cocktail party. You will see Xochimilco, the exotic Floating Gardens, where you will float along centuries-old canals in a flower-covered skiff. You will see all the sights of old and new Mexico City, the National Palace, charming shops, and Chapultepec Park and Palace. One day you will take the interesting drive to the Shrine of Guadalupe and the Pyramids of the Sun and the Moon. To add a special touch, you'll have luncheon at a private Mexican home. Then, of course, that most interesting of Mexican sports . . . the bullfights, even more exciting than the picture. On June 21, you may fly directly to your home city, or better, be in sunny, romantic Acapulco. Those who plan to go to Acapulco will leave Mexico City on June 20 for the delightful drive by air-conditioned limousine to the coast. Stop for a leisurely luncheon at the famous Hacienda Vista Hermosa, the former palace of Hernando Cortez. Along the way, a short visit to the premier mountain resort of Cuernavaca, then an afternoon of shopping and exploring the narrow, cobblestoned streets of Taxco, the silver center of Mexico. In Acapulco, stay at the delightful Las Brisas Hilton Hotel, pictured at the bottom, and enjoy four wonderful days of sun, fun, and leisurely relaxation in the most beautiful surroundings and unbelievably perfect climate. Depart, happy and suntanned, on June 24, for the return flight to Mexico City to connect with your flight home.

Program I Includes

- Transfer from hotel to airport in Los Angeles
- Jet flight from Los Angeles to Mexico City
- All transfers and baggage handling
- Six nights at Hilton Continental Hotel, European Plan, including all gratuities
- Sight-seeing tours of Mexico City, Xochimilco, Bullfights, Guadalupe, and the Pyramids
- Gala welcome cocktail reception at the hotel

All-inclusive price: $195 per person, double occupancy

Program II Includes

- Five nights at the Continental Hotel and all other features of Program I
- Limousine transfer from Mexico City to Acapulco, including lunch at the Vista Hermosa and an afternoon of shopping and sight-seeing at Taxco
- Four nights at fabulous Las Brisas, including two daily meals, hotel tips, and gratuities
- Return air transportation from Acapulco to Mexico City

All-inclusive price: $305 per person, double occupancy

REMIT DEPOSIT BY APRIL 30, 1961

EMBASSY TOURS, INC.

Group Sales Division
147 West 42nd Street
New York 36, N. Y.

Enclosed is my check for $..... ($50 per person) for ..... (number of persons) as deposit for the ASME Postmeeting Holiday in Mexico. I will remit full payment by May 20, 1961.

Check one: Single Room.....Double Room.....

Program I.....Program II.....

I do ..... do not ..... wish Embassy to arrange transportation to Los Angeles and return.

NAME.....

ADDRESS.....

.....

Please make checks payable to Embassy Tours

Engine Fuels and the Future—Keynote Topic of Oil and Gas Power Conference

FROM APRIL 9 to 13, 1961, the Oil and Gas Power Division of The American Society of Mechanical Engineers with the co-operation of the New Orleans Section will sponsor a conference to be held at the Jung Hotel, New Orleans, La. The conference theme is "Engine Fuels and the Future."

A feature of the conference is the exhibit, at which manufacturers in the Oil and Gas Power field display their products and recent developments, which has resulted in a closer tie with industry. All of us like to do business with people we know, people in whom we have confidence. At this meeting customer and supplier become better acquainted. Useful contacts develop and lasting friendships are formed.

In addition to six technical sessions at which a strong effort is being made to insure that the latest advances in oil and gas power are discussed, there will be a banquet, a boat trip on the steamer *President*, and a trip to the Kaiser Aluminum & Chemical Corporation Plant at Chalmette, La. There also will be citations given for outstanding service, OGP speaker awards, and a special lecture award.

Women are invited to attend the meeting to enjoy a planned program of activity such as a tour of the Garden District homes, luncheon on the *River Queen*, and breakfast at Brennan's.

▶MONDAY, APRIL 10

Session 1 **9:30 a.m.**

Operation of Dual-Fuel Engines in Pipeline Service, by *Erik Kelgard*, Trans Mountain Oil Pipe Line Co., Kamloops, B.C., Canada. (Paper No. 61—OGP-1)

Application of a Resilient Coupling to Avoid Resonance in a Diesel Engine Installation,[1] by *A. S. Herman, Jr.*, Koppers Co., Inc., Baltimore, Md.

Operation and Maintenance of Metallic Rod Packings for Reciprocating Compressors,[1] by *Gilbert Wilkes*, France Packing Co., Philadelphia, Pa.

Session 2 **2:00 p.m.**

Special Lecture

Lecturer: *M. A. Elliott*, Institute of Gas Technology, Illinois Inst. of Tech., Chicago, Ill.
Subject: **Fuels and the Future**

What's New?
Three-minute briefs of new developments in the industry by representatives of exhibiting manufacturers

▶TUESDAY, APRIL 11

Session 3 **9:00 a.m.**

A Multifuel Engine Experience, by *W. F. Isley*, Continental Aviation and Engineering Corp., Detroit, Mich. (Paper No. 61—OGP-6)

Cycle Analysis From Combustion Equations, by *L. T. Brinson*, Nordberg Mfg. Co., Milwaukee, Wis. (Paper No. 61-OGP-2)

Turbocharger Selection, Matching, and Development for Two-Cycle Spark Ignition Gas Engines,[1] by *W. H. Payne, G. H. Bollman*, and *R. L. Johnson*, Clark Bros. Co., Olean, N. Y.

▶WEDNESDAY, APRIL 12

Session 4 **9:00 a.m.**

Evolution and Development of a 900-Hp Marine Diesel Featuring Ruggedness and Serviceability in a 4½ Lb/Hp Package, by *L. Wechsler*, Bureau of Ships, Navy Department, Washington, D. C.; *L. Thompson* and *E. Tsakiris*, Curtiss-Wright Corp., Utica, Mich. (Paper No. 61—OGP-5)

Trends in Marine Diesel Fuel for the Navy, by *E. C. Davis*, Bureau of Ships, Navy Department, Washington, D.C. (Paper No. 61—OGP-4)

Session 5 **2:00 p.m.**

The Performance of 4-Cycle Gas Engines on Difference Fuels,[1] by *C. E. Holvenstot*, Ingersoll-Rand Corp., Painted Post, N. Y.

Wave Phenomena and Conditioning of Induced Air and Exhaust Gas in the Operation of Internal-Combustion Engines, by *B. G. Golden*, Burgess-Manning Co., Dallas, Texas. (Paper No. 61—OGP-7)

Electrochemical Cylinder Corrosion, by *J. M. A. Van der Horst*, Van der Horst Corp. of America, Olean, N. Y.; and *W. A. Schultze*, Lemet Chromium N. V., Hilversum, Holland. (Paper No. 61—OGP-3)

▶THURSDAY, APRIL 13

Session 6 **9:00 a.m.**

The Way to Automate—a Diesel Utility,[1] by *R. D. Hamilton*, The Cooper-Bessemer Corp., Mount Vernon, Ohio

Automatic Gaseous Fuel Controls,[1] by *R. G. Abbott*, American Bosch Div., Springfield, Mass.

Current Trends in Engine-Control Application,[1] by *C. R. Carmichael*, Amot Controls Corp., Richmond, Calif.

[1] Paper not available—see box on this page.

Availability of Papers

ONLY numbered ASME papers in this program are available in separate copy form until Feb. 1, 1962. Prices are 50 cents to members of ASME, $1 to nonmembers, plus postage and handling charges. Payment may also be made by free coupons, or coupons which may be purchased from the Society in lots of ten at $4 to members; $8 to nonmembers. **You can save the postage and handling charges by including your check or money order made payable to ASME with your order and sending both to: ASME Order Department, 29 West 39th Street, New York 18, N. Y.** Papers must be ordered by the paper numbers listed in this program, otherwise the order will be returned. The final listing of available technical papers will be found in the issue of MECHANICAL ENGINEERING containing an account of the conference.

Third Annual Hydraulic Conference, Montreal, May 7–11, Features St. Lawrence Seaway Trip

THIS conference will take place at the Queen Elizabeth Hotel and will be sponsored jointly by the Hydraulic Division of The American Society of Mechanical Engineers and The Engineering Institute of Canada.

In the past three years this conference has developed greatly in scope. This year's program is the most comprehensive yet, and covers many areas of hydraulics that are of current interest. The conference will include 15 technical sessions and inspection trips, and careful screening of technical paper insures a high quality of the subjects covered.

One of the high lights will include an inspection trip of the major engineering features of the St. Lawrence Seaway. This trip will be made by boat, and a luncheon will be included.

The fields of hydraulics to be covered include: Prime movers, fluid mechanics, cavitation, hydrology and ice, water hammer, compressors, and pumps.

For the women who plan to attend the conference, a special program has been set up which provides trips to the various points of interest that Montreal has to offer.

Specialists in their field have been invited to address the conference.

▶MONDAY, MAY 8

Session 1 Prime Movers—I **9:30 a.m.**

High Head Francis Turbines and Pressure Regulators—Mammouth Poll Project,[1] by *E. P. Brown*, Allis-Chalmers Mfg. Co., York, Pa.
Design of High Head Penstock, by *W. J. Smith*, Montreal Engineering Co., Ltd., Montreal, Que., Canada. (Paper No. 61—EIC-10)
The Quest for the Ultimate in the Interpretation of Experimental Data—An Engineering Challenge, by *L. E. Jones*, University of Toronto, Toronto, Ont., Canada. (Paper No. 61—EIC-12)

Session 2 Fluid Mechanics—I **9:30 a.m.**

A Flow Model for Two-Phase Slug Flow in Horizontal Tubes, by *E. S. Kordyban*, Linde Co., Tonawanda, N. Y. (Paper No. 61—HYD-12)
Adiabatic Flow of Flashing Liquids in Pipes, by *M. Sajben*, Westinghouse Elec. Corp., Lester, Pa. (Paper No. 61—HYD-7)
Local Liquid Distribution and Pressure Drops in Annular Two-Phase Flow, by *H. N. McManus*, Cornell Univ., Ithaca, N. Y. (Paper No. 61—HYD-20)

Session 3 Cavitation—I **2:30 p.m.**

Cavitation Tests of Hydro Foils Designed for Accelerating Flow Cascade, by *F. Numachi*, Tohoku Univ., Sendai, Japan. (Paper No. 61—HYD-1)

[1] Paper not available—see box on page 120.

ASME Papers by Mail

ONLY numbered ASME papers in this program are available in separate copy form until March 1, 1962. The ASME papers in this program are identified by the letters "HYD" as part of their number. Prices are 50 cents to members of ASME, $1 to nonmembers, plus postage and handling charges. Payment may also be made by free coupons, or coupons which may be purchased from the Society in lots of ten at $4 to members; $8 to nonmembers. **You can save the postage and handling charges by including your check or money order and sending both to: ASME Order Department, 29 West 39th Street, New York 18, N. Y.**

Papers must be ordered by the paper numbers listed in this program, otherwise the order will be returned. The final listing of available technical papers will be found in the issue of MECHANICAL ENGINEERING containing an account of the conference.

EIC Papers by Mail

ALL EIC papers in this program are available in separate copy and are identified by the letters "EIC" as part of their number. Prices are 50 cents to members of EIC and $1 to nonmembers, plus postage and handling charges. **You can save the postage and handling charges by including your check or money order and sending both to: EIC Technical Papers Order Department, 2050 Mansfield Street, Montreal 2, Canada.**

Papers must be ordered by the paper numbers listed in this program, otherwise the order will be returned.

Problems of Predicting Cavitation Erosion From Accelerated Tests, by *J. M. Hobbs*, National Engineering Lab., East Kilbride, Glasgow, Scotland, U. K. (Paper No. 61—HYD-19)
On the Mechanism of Cavitation Damage, by *C. F. Naude* and *A. T. Ellis*, California Inst. of Tech., Pasadena, Calif. (Paper No. 61—HYD-8)
Effect of High Velocities on Turbine Pitting, by *F. L. Lawton* and *M. D. Lester*, Aluminum Labs., Ltd., Montreal, Quebec. (Paper No. 61—EIC-2)

Fluid Mechanics—II

Session 4 **2:30 p.m.**

Preliminary Study of Turbulence Characteristics of Flow Along a Corner, by *F. B. Gessner* and *J. B. Jones*, Purdue Univ., Lafayette, Ind. (Paper No. 61—HYD-4)
The Effect of Secondary Currents Upon the Capacity of a Straight Open Channel, by *R. J. Kennedy* and *J. F. Fulton*, Queen's Univ., Kingston, Ont. (Paper No. 61—EIC-1)
Experimental Investigation of Subsonic Turbulent Flow Over Single and Double Backward Facing Steps, by *D. E. Abbott*, Vidya, Inc., Palo Alto, Calif., and *S. J. Kline*, Stanford Univ., Stanford, Calif. (Paper No. 61—HYD-15)

▶TUESDAY, MAY 9

Session 5 Water Hammer—I 9:30 a.m.

Surges in Air Vents Adjacent to Emergency Gates, by *I. W. McCaig* and *F. H. Jonker*, H. G. Acres & Co., Ltd., Niagara Falls, Canada. (Paper No. 61—HYD-2)
The Phase-Plane of the Simple Surge Tank Equation, by *A. W. Marris*, Univ. of Texas, Austin, Texas. (Paper No. 61—HYD-9)
Complete Pump Characteristics and the Effect of Specific Speed on Hydraulic Transients, by *B. Donsky*, U. S. Dept. of Interior, Denver, Colo. (Paper No. 61—HYD-3)

Session 6 Compressors—I 9:30 a.m.

An Experimental Investigation of the Use of Supersonic Driving Jets for Ejector Pumps, by *R. V. DeLeo, R. Rose*, and *R. S. Dart*, Univ. of Minnesota, Minneapolis, Minn. (Paper No. 61—HYD-13)
Characteristics of Helical Rotary, Positive Displacement Compressors, by *K. E. Wichert*, Fairchild Engine and Airplane Corp., Bay Shore, L. I., N. Y. (Paper No. 61—HYD-18)
A Correlation of Fan Performance for Solving Selection Problems, by *N. J. Lipstein*, Gen. Elec. Co., Schenectady, N. Y. (Paper No. 61—HYD-6)

Joint: Pumps and Prime Movers—I

Session 7 **2:30 p.m.**

Research Developments and Results Concerning Bulb Units, by *S. X. Casacci, J. P. Dupont*, and *E. F. Parisel*, Lasalle Hydraulics Lab., Ville Lasalle, Que. (Paper No. 61—EIC-13)
Vibration of Vertical Pumps, by *A. Kovats*, Foster-Wheeler Corp., New York, N. Y. (Paper No. 61—HYD-10)
Design Problems in Condenser-Circulation-Water System for Lakeview Generating Station, by *J. T. Wiechowski*, Hydro Electric Power Commission of Ontario. (Paper No. 61—EIC-14)

Fluid Mechanics—III

Session 8 **2:30 p.m.**

Flow of Water Through a Force Field in a Soil-Water System, by *R. Yong* and *O. J. Frenkel*, McGill Univ., Montreal, Que. (Paper No. 61—EIC-3)
Note on the Wind-Induced Circulation in the Gulf of St. Lawrence and Subsequent Drift of the Ice, by *G. E. Jarlan*, Hydraulics Lab., Ottawa, Ont. (Paper No. 61—EIC-15)
An Experimental Study of Vortex Chamber Flow, by *J. P. Holman*, Southern Methodist Univ., Dallas, Texas, and *G. D. Moore*, Wright Air Development Center, Wright-Patterson AFB, Ohio. (Paper No. 61—HYD-11)

▶WEDNESDAY, MAY 10

Joint: Compressors-Fluid Mechanics—I

Session 9 **9:30 a.m.**

Friction Drag on Bladed Disks in Housings as a Function of Reynolds Number, Axial and Radial Clearance and Blade Aspect Ratio and Solidity, by *R. W. Mann* and *C. H. Marston*, M.I.T., Cambridge, Mass. (Paper No. 61—HYD-5)
Generalized Multistage Compressor Characteristics, by *G. L. Mellor*, Princeton Univ., Princeton, N. J. (Paper No. 61—HYD-14)

Fluid Mechanics—IV

Session 10 **9:30 a.m.**

The Use of Wave Energy to Reduce Silt Deposition in a Harbour, by *B. Le Mehaute* and *J. Cowley*, Queen's Univ., Kingston, Ont. (Paper No. 61—EIC-7)
Moving Hydraulic Jumps in Fluidized Solids Systems, by *R. W. Ansley* and *R. H. B. Hebbert, Jr.*, Univ. of Alberta, Edmonton, Alta. (Paper No. 61—EIC-11)
The Effect of Mass-Transport of the Onset of Turbulence at the Bed Under Periodic Gravity Waves, by *J. I. Collins* and *A. Brebner*, Queen's Univ., Kingston, Ont. (Paper No. 61—EIC-8)

Fluid Mechanics—V

Session 11 **2:30 p.m.**

Parallel Development of Open-Channel Flow and Gas Dynamics, by *T. Blench*, Univ. of Alberta, Edmonton, Alta. (Paper No. 61—EIC-9)
Nonsteady Supercritical Discharge, by *G. Rudinger*, Cornell Aeronautical Lab., Buffalo, N. Y. (Paper No. 61—HYD-17)
Hydroelastic Vibrations of Flat Plates Related to Trailing Edge Geometry, by *G. H. Toebes*, Purdue Univ., Lafayette, Ind., and *P. S. Eagleson*, M.I.T., Cambridge, Mass. (Paper No. 61—HYD-16)

Hydrology and Ice I

Session 12 **2:30 p.m.**

On the Transfer of Heat from a River to an Ice Sheet, *W. D. Baines*, Univ. of Toronto, Toronto, Ont. (Paper No. 61—EIC-4)
Measure of Value and Statistical Models in the Economic Analysis of Flood Control and Water-Conservation Schemes, by *D. J. Clough, Jr.*, Univ. of Toronto, Toronto, Ont. (Paper No. 61—EIC-5)
Formation and Evolution of Ice Covers on Rivers, by *E. F. Pariset* and *R. Hausser*, Lasalle Hydraulics Lab., Ville Lasalle, Que. (Paper No. 61—EIC-6)

1961 ASME Applied Mechanics Conference Program Lists Authorities of World-Wide Reputations

THE three-day, 24th National Conference of The American Society of Mechanical Engineers, Applied Mechanics Division, June 14–16, 1961, will encompass the fields of elastic plates, shells, vibration of plates, vibrations and instability, fluid dynamics, and plasticity. Papers on specialized subjects within these fields are being prepared by noted authorities from throughout the world.

The 1961 conference will be cosponsored by Illinois Institute of Technology and the Chicago Section of ASME.

Social high lights of the conference will be an informal get-together Tuesday evening, a campus party Wednesday evening, and reception and banquet on Thursday evening. The main speaker for the banquet will be Dr. Jerome Namias, Chief, Extended Forecast Section, U. S. Weather Bureau, whose topic is "Abnormal Weather Patterns."

Rooms in a modern dormitory may be reserved for participants and/or their families who wish to stay on the campus under a package plan. The plan provides for housing on the campus for Tuesday, Wednesday, Thursday, and Friday nights, as well as breakfast and lunch on Wednesday, Thursday, and Friday. The cost of this package plan is a rather modest fee.

For the women, planned trips to Chicago museums and other points of interest may be arranged at the women's registration area. And for their convenience, baby sitters will be available while sight-seeing.

▶WEDNESDAY, JUNE 14

Session 1 Elastic Plates 10:00 a.m.

The Effect of a Rigid Elliptic Inclusion on the

ASME Papers by Mail

ONLY numbered ASME papers in the program are available in separate copy form until April 1, 1962. Prices are 50 cents to members of ASME, $1 to nonmembers, plus postage and handling charges. Payment may also be made by free coupons, or coupons which may be purchased from the Society in lots of ten at $4 to members; $8 to nonmembers. **You can save the postage and handling charges by including your check or money order and sending both to: ASME Order Department, 29 West 39th Street, New York 18, N. Y.**

Papers must be ordered by the paper numbers listed in this program, otherwise the order will be returned. The final listing of available technical papers will be found in the issue of MECHANICAL ENGINEERING containing an account of the conference.

Bending of a Thick Elastic Plate, by *Fu Chow*, Polytechnic Inst. of Brooklyn, Brooklyn, N. Y. (Paper No. 61—APM-13)
Bending of Cantilever Plates Supported From an Elastic Half Space, by *N. C. Small*, Univ. of Pittsburgh, Pittsburgh, Pa. (Paper No. 61—APM-11)
Bending and Stretching of Certain Types of Heterogeneous Aeolotropic Elastic Plates, by *Eric Reissner* and *Yenuda Stavsky*, M. I. T., Cambridge, Mass. (Paper No. 61—APM-21)
Torsion of Sandwich Plates of Trapezoidal Cross Section (by title only), by *Shun Cheng*, Univ. of Wisconsin, Madison, Wis. (Paper No. 61—APM-22)

Session 2 — 3:00 p.m.

Combined Bending and Extension of a Flat Orthotropic Plate Containing a Finite Crack, by *D. D. Ang* and *M. L. Williams*, California Inst. of Tech., Pasadena, Calif. (Paper No. 61—APM-19)
Bending of a Thin Cylindrical Shell Subjected to a Line Load Around a Circumference, by *H. R. Meck*, Pratt & Whitney Aircraft, Middletown, Conn. (Paper No. 61—APM-15)

▶THURSDAY, JUNE 15

Session 3 — 9:30 a.m.
Elastic Wave Theory

On Classical Plate Theory and Wave Propagation, by *M. A. Medick*, Avco Corp., Wilmington, Mass. (Paper No. 61—AP-3)
Stress Distribution on the Boundary of a Circular Hole During Passage of a Stress Pulse, by *A. J. Durelli* and *W. F. Riley*, Armour Research Foundation, Chicago, Ill. (Paper No. 61—APM-4)
Propagations of Elastic Waves Generated by Dynamical Loads on a Circular Cavity, by *A. C. Eringen*, Purdue Univ., Lafayette, Ind. (Paper No. 61—APM-12)
Diffraction of a Pressure Wave by a Cylindrical Cavity in an Elastic Medium, by *M. L. Baron* and *A. T. Matthews*, Paul Weidlinger, Consulting Engineering, New York, N. Y. (Paper No. 61—APM-26)

Session 4 — 2:00 p.m.
Vibrations and Instability

Extensional Vibrations of Elastic Orthotropic Spherical Shells, by *W. E. Hoppmann, II*, Rensselaer Polytechnic Inst., Troy, N. Y., and *W. E. Baker*, Ballistic Research Lab., Baltimore, Md. (Paper No. 61—APM-14)
Whirling of Unsymmetrical Rotors, by *P. J. Brosens* and *S. H. Crandall*, M.I.T., Cambridge, Mass. (Paper No. 61—APM-10)
On the Aero-Elastic Instability of Bluff Cylinders, by *G. V. Parkinson* and *N. P. H. Brooks*, Univ. of British Columbia, Vancouver, B. C., Canada. (Paper No. 61—APM-8)
A Bifurcation Phenomenon of Static Friction (by title only), by *F. F. Ling*, Rensselaer Polytechnic Inst., Troy, N. Y., and *R. S. Weiner*, Northwestern Univ., Evanston, Ill. (Paper No. 61—APM-7)
New Frequency Equations and Normal Modes for Flexural Vibrations of Beams, by *T. C. Huang*, Univ. of Florida, Gainesville, Fla. (Paper No. 61—APM-25)

▶FRIDAY, JUNE 16

Session 5 — Fluid Dynamics — 10:00 a.m.

The Effect of Longitudinal Gravitational Field on the Supercavitating Flow Over a Wedge, by *A. J. Acosta*, California Inst. of Tech., Pasadena, Calif. (Paper No. 61—APM-2)
Gas-Lubricated Cylindrical Journal Bearings of Finite Length, by *B. Sternlicht*, Gen. Elec. Co., Schenectady, N. Y. (Paper No. 61—APM-17)
Viscoelastic Effects in Birefringent Coatings, by *P. S. Theocaris*, Athens National Technical Univ., Athens, Greece, and *C. Mylonas*, Brown Univ., Providence, R. I. (Paper No. 61—APM-23)
Thermodynamic Analysis of the Darcy Law (by title only), by *R. G. Mohadam*, Indian Inst. of Tech., Kharagpur, S. E. Ry, India. (Paper No. 61—APM-5)
Theoretical Pressure Distribution in Journal Bearings (by title only), by *Kichiye Habata*, Sata Agricultural Machine Mfg. Co., Shimone, Prefecture, Japan. (Paper No. 61—APM-20)
Minimum Transfer Time for a Power Limited Rocket (by title only), by *G. Leitmann*, Univ. of California, Berkeley, Calif. (Paper No. 61—APM-6)

Plasticity

The following papers on Plasticity will be presented by title only:
The Stresses in an Elasto-Plastic Bar Subject to a Sudden Change of Surface Temperature, by *E. W. Parkes*, Univ. of Cambridge, Cambridge, England. (Paper No. 61—APM-16)
The Elastic, Plastic Bending of a Simply Supported Plate, by *G. Eason*, King's College, Newcastle-upon-Tyne, England. (Paper No. 61—APM-18)
Uniqueness in the Optimum Design of Structures, by *T. C. Hu* and *R. T. Shield*, Brown Univ., Providence, R. I. (Paper No. 61—APM-1)
An Extension of Duhamel's Analogy to Plasticity, by *S. A. Murch*, Univ. of California, Berkeley, Calif. (Paper No. 61—APM-9)
Plastic Stress-Strain Relationships—Further Experiments on the Effect of Loading History, by *J. Parker* and *J. Kettlewell*, Univ. of Manchester, Manchester, England. (Paper No. 61—APM-24)

Designing for the Competitive Market Sparks Biggest Design Engineering Show and ASME Design Engineering Conference, Cobo Hall in Detroit, May 22–25

THE 1961 Design Engineering Show and Conference will feature a substantially enlarged conference program and the largest exhibit ever held in the field. Both events, ideal partners—one to tell you how better product designs are achieved, the other to let you see and compare the materials, components, and services with which your design concepts can best be translated into reality—will take place at the new Cobo Hall, Detroit, Mich., May 22 through 25.

Devoted entirely to research and development of new products, the combined events will present the latest developments in materials and components which go into products, as well as design techniques to reduce production costs.

The show is being held in Detroit for the first time, the opening conference session will be entirely devoted to design engineering in the automotive field. Officials of Ford, Chrysler, General Motors, and American Motors, namely, Will Scott, H. M. Bevans, Conrad Orloff, and Carl E. Burke, respectively, will participate in the opening session on "Designing for Today's Competitive Market."

Many major companies will be represented by their top research engineers in other conference sessions. Such companies include General Electric, Corning Glass, Allegheny Ludlum Steel, Budd, Westinghouse, du Pont, Minnesota Mining & Manufacturing, A. O. Smith, North American Aviation, Monsanto, and Socony Mobil, among others.

Topics in the automotive session, which will have wide application in other fields, include "How a Car Is Planned and Engineered to Meet Marketing, Purchasing, and Quality Control Considerations," "Engineering Approach for Maximum Sales Value Per Unit of Cost," "Production Engineering of the Design of the New Car," and "The Role of the Supplier."

Many of the discussions will deal with research on atomic and space subjects which have application in the field of consumer products. A major topic, discussed in several papers, will be reduction of production costs through use of automatic machinery and methods of designing products so that they achieve the economies possible through automation.

Visitors who wish conference information, rapid registration cards for the show, and hotel information may write ASME Design Engineering Conference, 19th Floor, 341 Madison Avenue, New York 17, N. Y.

▶MONDAY, MAY 22

Designing for Today's Competitive Market — 10:00 a.m.

Engineers, today, must design to meet increasingly stiff domestic and overseas competition, and nowhere is competition keener than in the high production automotive industry. A panel of top-flight automotive executives will discuss their department roles in designing a superior product to meet this continuing competition. They will highlight the interplay of production, purchasing, and engineering by prepared discussion and later their answers to questions from conference participants.

Panel

How a Car Is Planned and Engineered With Marketing, Purchasing, Manufacturing, and Quality-Control Considerations, by *Will Scott*, executive director of Central Product Planning Office, Ford Motor Car Co., Dearborn, Mich.
Designing for Function and Cost Objectives, by *Herbert M. Bevans*, executive engineer—Chassis, Electrical, Truck Section, Engineering Div., Chrysler Corp., Detroit, Mich.
Production Engineering as It Affects Car Design and Sales, by *Conrad F. Orloff*, assistant chief engineer, Production Engineering Department, Chevrolet Motors Div., General Motors Corp., Detroit, Mich.
Role of the Supplier in Meeting Competition, by *Carl E. Burke*, chief development engineer, American Motors Corp., Detroit, Mich.

▶TUESDAY, MAY 23

Manufacturing—Key to Saving — 9:30 a.m.

Two key considerations that can reduce manufacturing costs are: producibility of a product and material standardization. What significant manufacturing techniques make a product "producible" and what savings can be derived from a material standardization program will be discussed.

Producibility—Designing for Production, by *C. E. Warner*, manager—Advanced Manufacturing Engineering Service, General Electric Co., Schenectady, N. Y., and *R. L. Berg*, consultant—Producibility Engineering, General Electric Co., Schenectady, N. Y. (Paper No. 61—MD-1)
Material Standardization to Reduce Costs,[1] by *G. L. Swartwood*, material engineer and drafting supervisor, The Bryant Electric Co., Bridgeport, Conn.

Automatic Equipment—Speeds Production — 9:30 a.m.

Modern machines use hydraulic power and special drives formerly thought impractical. Here's a pair of papers that outline the analysis of system dynamics and the matching of components to give high speed, high production, automated equipment.

Special Requirements of Hydraulic Circuits for Servo Controlled Machinery,[1] by *R. K. Sedgwick*, assistant chief engineer, Servo Div., Kearney and Trecker Corp., Milwaukee, Wis.
Drives for Tape-Controlled Machine Tools, by *G. W. Younkin*, chief development engineer, Giddings & Lewis Machine Tool Co., Fond du Lac, Wis. (Paper No. 61—MD-4)

Glass and Ceramics—Offer New Design Possibilities — 9:30 a.m.

Continuing analysis and testing are giving new insight into the physical, chemical, and mechanical properties of these engineering materials. The companion papers update present information and show newer engineering applications, and compare glass and ceramic with metal.

Ceramic Materials: A Chemical and Structural Description, by *M. G. Britton*, technical manager, Government Services Department, Corning Glass Works, Corning, N. Y. (Paper No. 61—MD-5)
What Do Glasses and Ceramics Offer the Design Engineer, by *J. R. Blisard*, manager, Product Engineering Department, Technical Products Div., Corning Glass Works, Corning, N. Y. (Paper No. 61—MD-6)

High-Strength Steel—Impact of Recent Development — 9:30 a.m.

Metallurgical and mechanical aspects of high-temperature cold-reduced stainless and precipitation-hardenable steels with examples on how to design and fabricate based on new developments.

High-Strength Steels—Part 1, Materials,[1] by *R. A. Lula*, chief research metallurgist—Stainless Steel, Allegheny Ludlum Steel Co., Pittsburgh, Pa.
High-Strength Steels—Part 2, Design and Fabrication,[1] by *R. H. Marvin*, chief engineer, SpaceAtomics Section, Product Development Department, The Budd Co., Philadelphia, Pa.

▶WEDNESDAY, MAY 24

Motors—Economics and Applications — 9:30 a.m.

An original equipment item that can offer real economies through weight and size reductions by being able to operate at higher temperatures. Many new applications are offered in the companion paper on synchronous units.

Electric Motors at Higher Temperatures for Industrial Usage, by *F. C. Rushing*, engineering manager, Motor and Gearing Department, Westinghouse Electric Corp., Buffalo, N. Y. (Paper No. 61—MD-9)
Mechanical Application of Nonexcited Synchronous Motors,[1] by *J. P. Landis*, development project engineer, Electromechanical Development Section, Mechanical Development Lab., E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.

Production—Cost-Saving Hints — 9:30 a.m.

Numerically controlled machines require special part design to give the greatest saving. At the same time, close tolerances and finishes add cost even though automatic machines can do the job. Charts permit optimum selection of all factors to reduce product cost.

Design Considerations and Drafting Techniques for Production on Numerically Controlled Production Machines,[1] by *Alexander Taleff*, equipment development engineer, Headquarters Mfg. Lab., Westinghouse Electric Corp., Pittsburgh, Pa.
Cost and Value of Small Tolerances and Smooth Finishes, by *W. W. Gilbert*, manager, Machining Development Service, Manufacturing Engineering Service, General Electric Co., Schenectady, N. Y. (Paper 61—MD-12)

Adhesives—For Metal Bonding — 9:30 a.m.

Adhesives are one of the newest methods of bonding metals, with bonded engine parts under test. Factors which must be known for most design problems are given. Discussed also are the differences between bonding metal parts and nonorganic materials.

Elastomeric Adhesives: Industry's New Tool,[1] by *W. C. O'Leary*, technical director, Adhesives, Coatings, and Sealers Div., Minnesota Mining and Mfg. Co., St. Paul, Minn.
Factors in Joint Design Using Adhesives for Metal Bonding, by *K. F. Charter*, director, Plastics Research, and *H. R. Butslaff*, supervisor, Plastics Research, A. O. Smith Corp., Milwaukee, Wis. (Paper No. 61—MD-14)

Cost Analysis—Fasteners and Powder Parts — 9:30 a.m.

Companion papers that evaluate the engineering and production problems pertaining to application, function, and design of standard and custom-engineered fasteners and powder-metal parts.

Which Fastener Should We Choose,[1] by *J. W. Stoutenburg*, vice-president, Robins Products Co., Warren, Mich.; and *K. D. Ringland*, chief engineer, Central Screw Co., Keene, N. H.
Designing With Powder Metallurgy to Improve Quality and Reduce Cost,[1] by *P. J. Failla*, general superintendent—Machine Shops, Johnson Bronze Co., New Castle, Pa.

▶THURSDAY, MAY 25

Plastics—Unusual Behavior — 9:30 a.m.

Two papers that indicate the influence of basic material properties on the end products. One considers the deceptively simple process of filament winding; the other points out specific areas where de-

[1] Paper not available—see box on page 123.

Scott

Bevans

Orloff

Burke

Availability of Papers

ONLY numbered ASME papers in this program are available in separate copy form until March 1, 1962. Prices are 50 cents to members of ASME, $1 to nonmembers, plus postage and handling charges. Payment may also be made by free coupons, or coupons which may be purchased from the Society in lots of ten at $4 to members; $8 to nonmembers. **You can save the postage and handling charges by including your check or money order made payable to ASME with your order and sending both to: ASME Order Department, 29 West 39th Street, New York 18, N. Y.** Papers must be ordered by the paper numbers listed in this program, otherwise the order will be returned.

sign problems are met with unusual types of behavior in plastics.

Filament Wound Pressure Vessels, by *Richard Gorcey*, group leader, Solid Propulsion Structural Components, Rocketdyne, Div. of North American Aviation, Inc., Canoga Park, Calif. (Paper 61—MD-17)

An Introduction to Designing With Plastics,[1] by *R. L. Thorkildsen*, mechanical behavior engineer, General Engineering Lab., General Electric Co., Schenectady, N. Y., and *J. V. Schmitz*, manager—Chemical Research, Major Appliance Chemistry Lab., General Electric Co., Louisville, Ky.

Dynamics—Damping and Gears **9:30 a.m.**

Two areas of continuing engineering problems on all manufactured products where vibration, shock, and misalignment are met. Both papers present new engineering solutions and are a must for engineers in the heavy equipment and automotive fields.

Viscoelastic Damping,[1] by *D. K. Hatch*, Engineer, Product Engineering Group, Plastics Div., Engineering Department, and *C. H. Adams*, manager, Product Engineering, Monsanto Chemical Co., Springfield, Mass.

Effect of Misalignment on Tooth Action of Bevel and Hypoid Gears,[1] by *M. L. Baxter, Jr.*, chief research engineer, Gleason Works, Rochester, N. Y.

Lubrication—Molydisulfides as an Answer **9:30 a.m.**

New lubrication frontiers are being probed and the authors answer many of the questions about what molybdenum disulfide materials can be expected to accomplish. Many misconceptions will be cleared up as laboratory testing and performance and material evaluations are offered.

Molybdenum Disulfide as a Lubricant,[1] by *K. B. Wood, Jr.*, manager, Chemical Div., Climax Molybdenum Co., Div. of American Metal Climax, Inc., New York, N. Y.

Molybdenum Disulfide as an Additive to Improve the Performance of an Automotive Multipurpose Grease,[1] by *H. G. Rudolph, Jr.*, Automotive Div., Products Department, Socony Mobil Oil Co., Inc., New York, N. Y.

[1] Paper not available—see box on this page.

Conducted for the National Junior Committee

J.W. FOLLANSBEE

JUNIOR FORUM

ECPD and Young Engineers

By J. W. Follansbee

AS I SAID when I took over the Junior Forum, I was going to cover a wide range of subjects. And so it's been. Jobs, unions, writing, the Junior Session, Winter Annual Meeting in New York City, and other subjects have appeared through the help of many. Now we go on.

This month starts a series that will look at the programs and philosophies of ASME and ECPD aimed primarily at the younger members. As you read the comments here, think about them. Maybe you think the ideas good—maybe bad. But regardless, after you think, act. Talk out your ideas among yourselves and with the older members. If you have questions, complaints, comments on what you read here, write them down, send them in. A mutual exchange of ideas always gets better results than a one-sided flow. But it works well only if there is a two-way flow of thought leading to the decision.

The concern of ASME about the development for their young members is not unique. An indication of this is seen in the ASME activity in Engineers' Council for Professional Development, a joint effort of eight engineering societies. ECPD has many committees, has prepared pamphlets and brochures, all aimed at helping engineers get a better understanding of their meaning to society, and of society. Rather than dwell on the history of ECPD, we will discuss the work it does.

The various societies that form ECPD recognized long ago that the most critical time period of an engineer's career was the first five years after graduation. So they formed a program called "The First Five Years of Professional Development—a Challenge." The aim is in the name, and it covers both technical and nontechnical areas of personal progress. The committee that drew up the program knew that while in college you had a set goal, and you followed a planned program, a curriculum, to reach it. That same principle still holds after you graduate. At this point, sooner or later, you have to determine what it is you want to accomplish and then map out a plan by which to do it.

First Five Years. Three primary principles guided the committee in forming their program. The first was opportunity for a favorable professional climate in which to grow, provided by your college, employer, and society. The second was counseling to assist you in making plans and in evaluating your progress. This is provided by the senior members of your profession. The third was responsibility for professional advancement; this rests solely with you. You're the only person that can make best use of the "First Five Years" program consistent with your own objectives and circumstances.

The program is divided into six parts. First is orientation and training in practice. This point is self-evident. Regardless of whether there is or isn't a formal orientation or training program where you work, there is a lot you can do on your own. Being alert and asking questions, reading available reports, plans, and other material concerning your employer and his activities, learning about other work areas in your department, and visiting other sections of the plant or project—with supervisory approval—all these can give you solid background data and help your self-development.

The second point covers continuing education. There is an axiom that for a professional man, education never ends. How true. And it includes everyone, not just the professional man. The problem here involves both responsibility and timing. When do you start up again with an educational program, or do you simply continue, on an informal basis, after graduation? To a large extent the answer depends on the person involved. It may be best to keep going immediately after school because of established study habits. Or you may not be ready then, and think it best to get in some experience to find where to

[1] Designer, Voorhees, Walker, Smith, Smith & Haines, New York, N. Y. Assoc. Mem. ASME.

deepen and broaden your technical knowledge. Still again, you might find, after waiting some time, that the broadening would be best in economic and management areas, in order to improve your financial position. Or you might want to continue your education simply for your own personal satisfaction. For all but one of these reasons, there is a waiting period. You are probably the only one who can tell when you're ready to continue, if you decide to wait. But once you recognize the signal to go on, that's the time to get help so your plan is well conceived.

Point three is professional identification. Your advancement at the start may depend largely on your technical abilities. Nevertheless, there are three vital steps you will want to take to guarantee your proper professional identification: (*a*) Be active in the society that represents your field of engineering activity; (*b*) get your professional registration; (*c*) identify yourself as an exemplary professional man through your personal conduct. Through your activities in the society of your choice you'll get an understanding of the significance of the "Canons of Ethics" and the Code of Ethics of the Society as well as get to know the men around you.

A fourth point is responsible citizenship. One of the best ways to get with it in your community is through making a personal contribution, not of money, but of work. Where you work could vary from religious to political, with social, educational, welfare, and numerous others from which to choose. It makes no difference. Because of your technical knowledge you can contribute to many projects in areas where others cannot. But you will find your efforts command respect and attention, and, conversely, you will do the same for others. Later, you can help other young men coming along to do the same.

The fifth point of the program covers selected reading. Two important attributes you will need as a successful engineer are the ability to deal with men and affairs, and the ability to read and absorb the written experience of others. In many cases these abilities must be developed after graduation by the individual. A good way to develop both these abilities is simply to read. But read with a plan or program. Break it into three parts: general, technical, and professional. The first includes nontechnical writings—biography, travel, history, economics, philosophy, and psychology as well as fiction. A representative list on these subjects is found in the ECPD pamphlet "Reading List for Young Engineers." It should be called a reading list for anyone, since it contains many fine books in all areas, and it would be good reading for politicians and school teachers as well as engineers. Write to ECPD, 29 West 39th Street, New York 18, N. Y., and get this pamphlet. It's not a stogy "The Best Hundred Books" nor is it only a list of the "classics." Many of the books mentioned were published in the past ten years. Use this as a guide—discuss it with your friends, young and old, and get their opinions. Then dig in and read. You'll enjoy it. The second area is texts, the third, technical publications.

Last point on the program is personal appraisal. Your success depends, for the most part, on working in a field for which you're well suited because of education, aptitude, and interests. Every now and then take time off to take stock of where you are. What are the personal and technical requirements of your position, and of others? Can you use your abilities to the best advantage where you are and in relation to your goals? Is there something holding you back? Answering these questions will help considerably in following the plan you've made to achieve your goals.

These are the six points of the First Five Years Program. There are pamphlets and brochures covering individual points as well as all six. Later, in the "Junior Forum," I'll go into these points, as well as other activities of ECPD. And, as was said earlier, discuss these ideas and let us have your comments.

ASME CODES AND STANDARDS WORKSHOP

Interpretations of Code for Pressure Piping

From time to time certain actions of the Sectional Committee B31 will be published for the information of interested parties. While these do not constitute formal revision of the Code, they may be utilized in specifications, or otherwise, as representing the considered opinions of the Committee.

Pending Revision of the Code for Pressure Piping, ASA B31, the Sectional Committee has recommended that ASME, as sponsor, publish selected interpretations so that industry may take immediate advantage of corresponding proposed revisions. Cases 32 (Reopened), 49, 50 and N-11 are published herewith as an interim action of Sectional Committee B31 on the Code for Pressure Piping that will not constitute a part of the Code until formal action has been taken by the ASME and by the ASA on a revision of the Code.

Case 32 (Reopened)

Inquiry: Is the use of centrifugally cast carbon steel, low alloy, and austenitic stainless pipe permissible under ASA B31.3-1959 Code for Pressure Piping?

Reply: It is the opinion of the Committee that centrifugally cast pipe is suitable for use in piping systems under ASA B31.3-1959 Code for Pressure Piping, if the following requirements are met:

1 The pipe materials shall meet the requirements of ASTM Specification A216, A351, A426, or A426 modified to exclude the requirements for ultrasonic inspection.

2 Piping made of materials conforming to A216 and A351 shall have both the inner and outer surfaces machined to a finish not coarser than 250 RMS after heat-treatment.

3 Each piece of pipe made of materials conforming to A216 and A351 shall be examined on the inside and outside surfaces by a magnetic particle method or a liquid-penetrant method of surface inspection whichever is feasible for the material after machining of the inside and outside surfaces, including the ends and after hydrostatic test. When magnetic particle inspection is used, it shall be made in accordance with the Method for Dry Powder Magnetic Particle Inspection (ASTM E109), or by a wet method agreed upon by a manufacturer and purchaser. The details of the liquid-penetrant method shall be a matter of agreement between the manufacturer and purchaser. Any crack-like or other injurious defects revealed by these methods shall be repaired.

4 When specified in the engineering design, each piece of pipe shall be ultrasonically or radiographically tested throughout its length after machining to determine its soundness. When pipe is tested ultrasonically, discontinuities in excess of 5 per cent of the wall or thickness shall be cause for rejection or repair. Either the shear or longitudinal methods of ultrasonic testing shall be used. When pipe is tested radiographically defects as judged by the industrial radiographic standards for steel casting (ASTM E71, Class II) shall be cause for rejection or repair. (It should be recognized that austenitic casting may not be amenable to ultrasonic inspection.)

5 Each length of pipe made of material conforming to Specification A216 and A351 shall be tested after machining by the manufacturer to a hydrostatic test pressure which will produce in the pipe at atmospheric temperature a stress of 60 per cent of the specified minimum yield strength.

This pressure shall be determined by the formula:

$P = 2st/D$ where:
P = minimum hydrostatic test pressure (psi).
s = 60 per cent of the specified minimum yield strength or yield point.
t = actual wall thickness, in.
D = outside diam of pipe, in.

The test shall be maintained for not less than five (5) minutes.

6 Flattening tests on pipe intended for bending shall be as prescribed in Specification A426-58T with following values of "e" to be used where applicable:

A216	0.07
A351 (austenitic)	0.09
A351 (ferritic)	0.07

7 The wall thickness of the casting shall be determined in accordance with the applicable paragraphs of Chapter II, Part 2, of the ASA B31.3-1959 Code except that the permissible stress values shall be as shown in the appended table. To arrive at the "S" value, the appropriate casting quality factors in Paragraph 8 below shall be applied.

Note: The stress table should show the allowable stresses for materials without any casting factor.

8 The following casting quality factors shall govern:

(a) Minimum requirements of this case (including machining inside and outside plus magnetic particle inspection or liquid penetrant) ..... 90 per cent

(b) 100 per cent ultrasonic or 100 per cent radiographic inspection in addition to requirements in (a) above .. .. 100 per cent

9 The foregoing requirements establish interim provisions for A351 and A216 until such time as further ASTM Specifications on centrifugally cast pipe become available and are accepted by the committee.

Case 49, Code Section to Be Used for Chemical-Industry Piping

Inquiry: Is THERE a Code Section of ASA B31 (Code for Pressure Piping) by which chemical process industry piping may be designed, fabricated, inspected, and tested?

Reply: It is the opinion of the Committee that until such time as an ASA Pressure Piping Code Section specifically applying to chemical-process piping has been published, chemical process piping may be designed, fabricated, inspected, and tested in accordance with the requirements of ASA B31.3, Petroleum Refinery Piping.

Case 50—Allowable Stresses for Materials Listed in B31.1-1955

Inquiry: SECTION 1 of ASA B31.1-1955, Code for Pressure Piping, lists allowable stresses for only a limited number of piping materials. What stresses may be used for those materials listed in Table 1 for which no stresses are given?

Reply: It is the opinion of the Committee for Section 1 of ASA B31.1-1955, Code for Pressure Piping, that where it is desired to use materials mentioned in the above inquiry, the stresses given in Power Boilers, Section 1, of the ASME Boiler and Pressure Vessel Code, apply. The intent of the Code for Pressure Piping will be met inasmuch as the basis for establishing stresses set forth in Table P-7 of the ASME Section 1, Power Boiler Code, has been adopted as the basis used under the requirements of Section 1 of the Code for Pressure Piping.

Case No. N-11—Requirements on Expansion Joints for Nuclear Piping

Inquiry: What means may be used to provide thermal expansion in nuclear piping systems?

Reply: It is the opinion of the committee that any sound means of providing for thermal expansion may be used. It is recommended that these means be provided by plain or corrugated pipe bends, offsets, changes in direction of the pipe line itself, or bellows expansion joints, sliding type joints or swivel type joints. Whatever means are used must meet the following requirements:

1 Provision for expansion must meet the requirements of ASA B31.1-1955, Section 6, Chapter 3.

2 Be of materials recognized by ASA B31.1 and Code cases prefixed by "N" as satisfactory for the specified conditions.

3 If of a sliding or swivel type have a positive seal or a leakoff which reasonably assures that the leakoff will be contained within the main or auxiliary nuclear piping system.

4 The designer is cautioned to provide for unusual thermal expansion due to rapid temperature fluctuations, especially in liquid-metal-piping systems.

Addenda to Code for Pressure Piping

THE 1959 Addenda to several B31, Code for Pressure Piping, standards have been published, which cover the latest list of material specifications approved by the American Standards Association in August, 1960.

The Addendum to B31.1-1955, Code for Pressure Piping, replaces the Appendix to Section 7.

Supplement 1 to B31.3-1959, Petroleum Refinery Piping, includes the revised list of specifications for Tables 392.1 A and B, 304.5.1 A and B, of the standards in the Appendix and a revision of the footnote for Table 326.1.

The Addendum to B31.4-1959, Oil Transportation Piping, supercedes Appendix Tables 3 and 4.

The Addendum to B31.8-1958, Gas Transmission and Distribution Piping Systems, updates the standards and specifications listed in Appendix A.

These addenda are available through the Order Department of ASME, 29 West 39th Street, New York 18, N. Y., at 50 cents per addendum and supplement.

Errata

AMERICAN Standard Practice for the Inspection of Elevators, Inspectors' Manual, ASA A17.2-1960. The following correction has been called to our attention.

Paragraph 2 of Item 7A on page 18 should be corrected to read:

"On doors or gates equipped with interlocks which are unlocked automatically by retiring cams or similar devices, when the car is in a landing *or leveling* zone, place the car at each landing at such a position above and below the landing that the automatic unlocking device on the car cannot release the interlock and determine that these positions do not exceed 18 in. above or below the landing, *or 30 in. where an automatic leveling device is used.* Then follow the procedure outlined in the previous paragraph."

(The italicized phrases are the corrected additions to the original paragraph.)

ACTIONS ASME EXECUTIVE COMMITTEE

A MEETING of the Executive Committee of the Council was held in the rooms of the Society on Friday, Feb. 3, 1961. There were present: W. H. Byrne, Chairman; D. E. Marlowe and L. N. Rowley of the Executive Committee; W. H. Larkin, Director; G. B. Thom, Vice-President; E. J Kates, Treasurer; E. J. Schwanhausser, Finance Committee Chairman; J. H. Hitchcock and E. L. Robinson, ASME Representatives to The Engineering Foundation; W. L. Betts, ASME Representative to the Engineering Societies Library; F. E. Lyford, Committee on Professional Practice; O. B. Schier, II, Secretary; W. E. Letroadec, S. A. Tucker, and J. D. Wilding, Assistant Secretaries; H. I. Nagorsky, Controller; and D. B. MacDougall, Associate Head, Field Service.

President Byrne appointed W. H. Larkin and G. B. Thom to act for H. N. Muller and R. B. Smith, members of the Executive Committee, who were unable to attend the meeting.

The Council noted with deepest sympathy the passing of Director R. B. Smith's mother on Feb. 1, 1961.

Board on Technology. ***1961 Summer Annual Meeting.*** The Meetings Committee is planning a postmeeting tour to Mexico following the 1961 Summer Annual Meeting in Los Angeles, Calif.

1961 Winter Annual Meeting. The Meetings Committee has scheduled the Banquet for Wednesday, Nov. 29, 1961, during the 1961 Winter Annual Meeting in New York City.

Divisional Conferences. The following 1961 Divisional Conferences have been approved by the Meetings Committee and the Board on Technology: Lubrications Symposium, May 9–10, Miami Beach, Fla., and Oil and Gas Power Conference, April 9–13, New Orleans, La.

1962 Summer Annual Meeting. The Secretary reported that the Meetings Committee had received the release of the Cincinnati Section who were to have been host to the 1962 Summer Annual Meeting and that definite commitments for the week of June 11, 1962, have been made with the Chateau Frontenac, Quebec. A further report regarding the length of the meeting and general format will be presented to the Executive Committee at a later date.

Research Executive Committee. ***Research Committee on Elevators.*** The Council authorized the transfer of $603.09 remaining in the custodian fund of the discharged Research Committee on Elevators to the General Research Fund (G-37) of the Society.

Research Committee on Heat Conduction Charts. The Council authorized the transfer of $341.52 remaining in the custodian fund of the discharged Research Committee on Heat Conduction Charts to the General Research Fund (G-37) of the Society.

Research Committee on Bulk Materials. The Council authorized a $137,500 fund-raising campaign to underwrite the cost of the Research Committee on Bulk Materials to investigate various phenomena associated with the gravity flow of bulk materials.

Supplemental Research Agreements. The Secretary signed the following supplements to existing Research Agreements for projects sponsored by the ASTM-ASME Joint Committee on the Effect of Temperature on the Properties of Metals:

1 Supplement No. 3 to Research Agreements 7DP-11 and 13 with Battelle Memorial Institute extending the expiration date for a period of 12 months to Jan. 31, 1962, with no change in the cost of the project.

2 Supplement No. 1 to Research Agreement 7DP-14 with Battelle Memorial Institute extending the expiration date for a period of six months to Aug. 31, 1961, with no change in the cost of the project.

3 Supplement No. 4 to Research Agreement 7SP-5 with the University of Michigan extending the expiration date from Oct. 1, 1960, to Dec. 31, 1961, and increasing the maximum cost from $27,500 to $47,000.

4 Supplement No. 3 to Research Agreement 7SP-6 with the University of Michigan extending the expiration date for a period of eleven months to Dec. 31, 1961, and increasing the maximum cost from $40,000 to $60,000.

Professional Practice Committee. ***Architects and Engineers.*** The Council voted: (*a*) To adopt the Resolution on the Practice of Engineering and Architecture prepared by the ASME Professional Practice Committee; and (*b*) to present the Resolution to the New Jersey Society of Professional Engineers as an endorsement of the Engineers' position in that State.

Sections. ***Southern Arizona Group of the Arizona Section.*** The Council voted: (*a*) To authorize subsection status for the Southern Arizona Group of the Arizona Section with headquarters at Tucson, Ariz., and consisting of the following Arizona counties: Cochise, Graham, Greenlee, Pima, Pinal, and Santa Cruz, and (*b*) to authorize an additional payment of $75 to bring the Second Half allotment of the Southern Arizona Subsection to $100.

Revision of ASME Constitution, By-Laws, and Rules

To: Members of ASME

UPON authorization of the Council a few years ago, a subcommittee of the Constitution and By-Laws Committee was appointed "to consider and prepare a general revision of the Constitution, By-Laws, and Rules." G. M. Muschamp, *Chairman*, L. E. Herbert, and L. C. Smith, who comprise the subcommittee, worked on the revision for more than two years and it is now ready for submission to the Council for action at its meeting in Los Angeles, Calif., June 11–12, 1961.

No substantive changes have been made but inconsistencies and duplications have been eliminated and, in particular, the form and arrangement of the matter have been revised.

On the assumption that the Council will make no changes in the revision, there will be a presentation at the Business Meeting in Los Angeles, June 12, 1961, by the Constitution and By-Laws Committee of proposed transposition of 14 Constitution items to By-Law status and the transposition of six By-Law items to Constitution status. Copies of these items will be available at the Business Meeting. After discussion and possible modification at the Business Meeting these items will be mailed, about Aug. 15, 1961, to the membership for letter-ballot action.

A limited number of copies of the 40-page revision is available upon request from the Secretary's Office, 29 West 39th Street, New York 18, N. Y.

El Paso Subsection of the New Mexico Section. The Council voted: To authorize the formation of the El Paso Subsection of the New Mexico Section with headquarters at El Paso, New Mexico, and consisting of the following counties in *New Mexico:* Grant, Sierra, Hidalgo, Luna, Dona Ana, Lincoln, Chavez, Eddy, Roosevelt, Otero, and Lea. *In Texas:* Hudspeth, Culpertson, Reeves, Pecos, Terrell, Jeff Davis, Brewster, El Paso, and Presidio.

Transfer of Counties to Saginaw Valley Subsection. The Council voted: To ininclude the following Michigan counties in the territory of the Saginaw Valley Subsection of the Detroit Section: Genesee, Huron, Lapeer, Sanilac, and Tuscola.

Member Gifts Campaign. ***Report.*** W. H. Larkin presented the following report on the progress made since September, 1960, in the Member Gifts Campaign.

Progress during the last four months of the United Engineering Center campaign places ASME just $56,514.88 short of its quota of $800,000. Since September 30 we have had the highest weekly income of the five founder societies in 12 of the 17 elapsed weeks. During this period our position has improved by $34,264.09 net.

Our progress is shown in the following tabulation:

September 30, 1960, Amount short of quota		$90,778.97
Received during		
4 week period ending 10/28	$ 5,258.96	
4 week period ending 11/25	12,166.88	
5 week period ending 12/30	9,920.59	
4 week period ending 1/27	7,851.66	
	$35,198.09	
Less adjustments	934.00	34,264.09
Balance due January 27, 1961		$56,514.88

It is expected that continued activity at the Section level, and the receipt of several major gifts, will place us close to our goal this spring.

At the present time 26 Sections are over the top, or within a fraction of a percentage point of this goal. Four others are over 90 per cent of quota, and Section activity indicates they, too, should join the 100 per cent club.

Engineers' Council for Professional Development. ***Charter Ratification.*** The Executive Committee of the Council voted: To ratify the Dec. 2, 1960, amendments to the ECPD Charter.

Proposed Amendments to Rules of Procedure. The Executive Committee of the Council voted:

To ratify the December 2, 1960, amendments to the Rules of Procedure of ECDP.

Admission of Other Societies to ECPD. Since January, 1955, ECPD has sought the approval of the participating bodies to permit the admission of NSPE into ECPD. At first the ASME Council withheld action; however, a subsequent request from ECPD led the Council to record its favoring an invitation to NSPE to become a member of ECPD.

In May, 1957, a request for admission of the Institute of Aeronautical (now Aerospace) Sciences, Inc., was tabled pending a charter change by ECPD to permit the admission of additional societies.

In 1958, the ASME Council reaffirmed admission of NSPE, approved the admission of the Institute of Aeronautical (Aerospace) Sciences, Inc., and the Institute of Radio Engineers, and suggested a change in Item 1 of the Charter of ECPD to add NSPE, IAS, and IRE as participating bodies of ECPD.

In view of the change in Item 1 of the ECPD Charter, the Executive Committee of the Council voted: To reaffirm its approval of the admission of NSPE, IAS, and IRE as participating bodies of ECPD.

Engineers Joint Council. ***American Society of Agricultural Engineers.*** The Council approved the admission of the American Society of Agricultural Engineers as a Constituent Society of EJC.

International Exposition Company, Inc. ***1960 Power Show.*** The International Exposition Company, Inc., has sent checks amounting to $8,599.23 from the 1960 Power Show, which will be deposited in the General Research Funds of the Society.

Certificates of Awards. ***Codes and Standards.*** On approval of the Board on Codes and Standards, certificates of award have been prepared for the following for their outstanding leadership in the development of Standards and Codes sponsored by the Society: James L. Keane, ASA Sectional Committee A113; and David C. Carmichael, B31 Section Committee No. 5.

Regional Chairmen. A certificate of award has been prepared for Frederick J. Heinze who served as the Region III Publications Committee Advisory Member 1956–1960.

Member Gifts Chairman. The Council authorized the preparation of a certificate of award for T. F. Furlong in recognition of his efforts in leading the Northwest Florida Section Member Gifts Campaign to 100 per cent member participation and 145 per cent of quota.

Appointments. ***Vice Presidential.*** Vice-President Jensen, Region X, appointed James M. Todd to represent the Society on April 15, 1961, at the Inauguration of Herbert E. Longnecker as President of Tulane University, New Orleans, La.

ASME COMING EVENTS

April 6–7, 1961

ASME-SAM Management Engineering Conference, Statler Hilton Hotel, New York, N. Y.

April 9–13, 1961

ASME Oil and Gas Power Conference and Exhibit, Jung Hotel, New Orleans, La.

April 10–11, 1961

ASME Maintenance and Plant Engineering Conference, Bancroft Hotel, Worcester, Mass.

April 23–26, 1961

ASME Metals Engineering Conference, Penn-Sheraton Hotel, Pittsburgh, Pa.

May 7–10, 1961

ASME-EIC Hydraulic Conference, Queen Elizabeth Hotel, Montreal, Que., Canada

May 8–9, 1961

Lubrication Symposium, Deauville Hotel, Miami Beach, Fla.

May 10–12, 1961

ASME Production Engineering Conference, Royal York Hotel, Toronto, Ont., Canada

May 22–25, 1961

ASME Design Engineering Conference and Exhibit, Cobo Hall, Detroit, Mich.

June 11–14, 1961

ASME Summer Annual Meeting, Statler Hilton Hotel, Los Angeles, Calif.

June 14–16, 1961

ASME Applied Mechanics Conference, Illinois Institute of Technology, Chicago, Ill.

August 28–30, 1961

ASME West Coast Conference of Applied Mechanics, University of Washington, Seattle, Wash.

August 28–September 1, 1961

Second International Heat Transfer Conference, University of Colorado, Boulder, Colo.

September 14–15, 1961

ASME-AIEE Engineering Management Conference, Hotel Roosevelt, New York, N. Y.

September 24–27, 1961

ASME-AIEE National Power Conference, St. Francis Hotel, San Francisco, Calif.

September 24–27, 1961

ASME Petroleum Mechanical Engineering Conference, Muehlebach Hotel, Kansas City, Mo.

October 4–6, 1961

ASME Process Industries Conference, Shamrock Hilton Hotel, Houston, Texas

October 17–19, 1961

ASME-ASLE Lubrication Conference, Morrison Hotel, Chicago, Ill.

November 26–December 1, 1961
ASME Winter Annual Meeting, Statler Hilton Hotel, New York, N. Y.

(*For Meetings of Other Societies, see page 115.*)

Note: Persons wishing to prepare a paper for presentation at ASME National meetings or Division conferences should secure a copy of Manual MS-4, "An ASME Paper," by writing to the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Price to nonmembers, 50 cents; to ASME members, free. Also available on request is a "Schedule of Program Planning Dates for Meetings and Publication Deadline Dates." Ask for Form M&P 1315.

Men Available[1]

Chicago Office

Vice-President or General Sales Manager, BSME; 43; ten years' experience engineering large industrial equipment; 13 years as sales engineer and sales manager of company manufacturing heavy industrial equipment. Registered engineer, Ohio and Wis. Immaterial. Me-2120-Chicago.

Engineer, Management Level, BSME; 38; experience in equipment layout, production scheduling, maintenance, development, mostly in the rubber and plastic fields. $10,000. Cleveland-Chicago area. Me-2121-Chicago.

Project Engineer, Development, BSME Purdue; 25; two years diesel engine-parts development on pistons cylinder liners and lash adjusters; 1½ years heat-transfer research on nuclear-fuel materials. Open. Chicago. Me-2122-Chicago.

Mechanical Engineer, BSME; 29; experience in construction supervision, structural, mechanical, and electrical construction estimating for five years; design of mechanical remote handling and inspection equipment for two years; contract administration for Navy Construction projects. Open. Immaterial. Me-2124-Chicago.

Quality-Control Engineer, BME, PE, N. Y.; 30; quality-control engineer on ranges, heating units, thermostats. Can apply process capabilities quality costs, inspection plans, and special studies. Vendor liaison missile components. Knowledge of sheet metal, metal machining, porcelain enameling, and plating. Open. East or Chicago. Me-2125-Chicago.

Engineer, BSME, 1948; 37; experience in plant engineering and design, construction, and building maintenance in food, grain, and chemical industries. $10,000. Midwest. Me-2126 Chicago.

Mechanical Engineer, BS (Mechanical) 1958; 25; responsible for product design for light metal-working industry including supervision of design section Emphasis on feasibility, stress analysis, testing of mass produced cold-worked metal products. Experienced in co-ordinating projects from customer contact through prototyping, to pilot production. $8400. East or midwest. Me-2127-Chicago.

New York Office

Project-Development Engineer or Operations-Planning Engineer, BSME; three years design-project engineering, nylon production, and auxiliary equipment; two years designing fuse components and supervising tests for government; four years' R & D designing, developing new processes and products with one year supervisory responsibility. Seeking project development or operations planning with management potential. Minimum $8700. Will relocate. Prefers Northeast. Me-925.

Project Engineer, BS (Engineering); ten years' experience in special applications of tungsten carbide. Supervision of design, manufacture, installation of specialty items and wear parts. Design and development of new methods of applying carbides. Conducting tests in customers' plant. Open. Immaterial. Me-926.

District Manager, Sales, New York, recently retired, ME degree, industrial and railway-equipment background, available for sales representation. Alternatively, for temporary assignment to guide manufacturer's representative new to this area. Further available for consulting activity on phases of international sales, surveys. $12,000. New York area preferred. Me-927.

Programmer, or work relating to heat transfer, BSME; for the past six months working on a project titled "The Marine Traffic Control System for the Panama Canal Zone." $6500. Open. Me-928.

Plant Engineer, Maintenance Engineer, or **Superintendent,** BSME; 40; ten years' varied manufacturing experience in precision machining and assembly, refrigeration and air conditioning, chemical process, and aluminum-rolling mill. Plant, production, maintenance, and utilities engineering; plant layout, quality control, and maintenance supervision. $9000. Midwest, South, or Foreign. Me-929.

[1] All men listed hold some form of ASME membership.

Positions Available

Chicago Office

Senior Industrial Designer, IE, at least eight years' industrial design, product-development experience. Interest in mechanical design and familiar with limited-volume production processes is absolutely essential. Must be mature, self-energized, creative designer capable of both personal contribution and technical supervision of industrial designers. Responsible for group of x-ray and related products. Opportunity to contribute in areas of visual character. Should be personable and capable of working effectively with marketing, engineering, and manufacturing counterparts as well as design staff for a manufacturer of x-ray equipment. About $10,000. Midwest. C-8557.

Senior Design Engineer, BSME; four years' machine-design experience. Design of new or experimental strapping tools and machinery. Check finished drawings and tools and accessories. Ascertain customers' requirements. Analyze new experimental designs of equipment and investigate complaints. Supervise and co-ordinate work of assigned engineers and draftsmen for a producer and manufacturer of steel and steel products. To $10,500. Company pays fee. Chicago, Ill. C-8547.

Manufacturing Engineer, BSME; 35–50; five years' experience as manufacturing specialist in industry producing small mechanical and electrical products, knowledge mechanical engineering and manufacturing. Will serve as top manufacturing engineer. Must be able to conceive operation in terms of automation and be able to sell his ideas; for a manufacturer of controls. $10,000–$12,000. Company pays fee. Ill. C-8535.

Design and Development Engineer, to 30; BSME from accredited university, at least three years' experience as design and development engineer on mechanical, pneumatic, or hydraulic flow controls or instruments, including valves, pneumatic switches and motors, thermostats, servomechanisms, meters, recording devices, or small mechanisms. Imaginative, resourceful individual with a high mechanical aptitude and knowledge of manufacturing problems and methods, $8400–$9600, plus fringe benefits and profit sharing. Company pays fee. Chicago area. C-8520.

District Sales Engineer (Crusher and Process-Machinery Division), graduate engineer preferred, minimum of five years' machinery-sales experience in mining, crushed stone, sand and gravel, or cement industry, or extensive and proved record in heavy machinery sales. Position requires about 75 per cent traveling; contacting customer prospects for application and sales of crushers, grinding mills, rotary driers, kilns, coolers, etc., used for the processing of ores and minerals. To $9000. Company pays fee. Headquarters, Wis. C-8519(*a*).

New York Office

Teaching Personnel for Mechanical-Engineering Department. (*a*) One with PhD in the field of machine dynamics and design. (*b*) Head of Mechanical-Engineering Department, PhD preferred but adequate reputation, administrative competence, and high ability in the general field of mechanical engineering would receive favorable consideration without PhD degree. Midwest. W-135.

Project Manager, graduate mechanical, chemical, or aeronautical, four to six years' experience in the design of important mechanical devices and mechanisms. Under general supervision, will plan, conduct, and supervise assignments normally involving several small projects or one major project; estimate manpower needs and schedule work to meet completion dates, etc. Occasional travel. $10,000–$120,000. Pa. W-132.

Sales Engineer, mechanical graduate, estimating, specification, and field-sales experience covering reciprocating compressors, diesel power units for oil field, industrial, and military installations. Must be U. S. citizen. $8,000–$10,000. New York, N. Y. W-129.

Engineer, opportunity for future vice-presidency; must be experienced in plant design for firm which is leader in its field. Experience in coal preparation helpful. Apply by letter giving experience and earnings record. South. W-62.

Engineers. (*a*) Service engineers, graduate mechanical, one to three years' experience. Position involves supervision of start-up and initial operation, conducting performance and acceptance tests, trouble shooting, handling breakdown problems, and training client's personnel on steam-generating and heat-transfer equipment. Must be free to travel; allowances provided. To $7800. (*b*) Proposal engineer, graduate mechanical, two to four years' experience in steam-generating-equipment fields. Knowledge and interest in heat transfer, thermodynamics, and fluid flow essential. To $7800. New York, N. Y. W-51.

Senior Manufacturing Engineer, Brazed Aluminum, 30–40, six to ten years' experience in the fields of furnace brazing and light sheet-metal fabrication. Will be responsible for manufacturing processes, tooling, and methods for the production of furnace-brazed aluminum and stainless-steel products. $9000–$11,000. Company pays fee. Midwest. W-109.

Fabrication Manager, at least five years' supervisory production experience in ceramic-fabricating techniques—casting, extruding, pressing, and sintering of high-temperature oxides to be responsible for production, plant layout, equipment, process, inspection, and packaging. Open. Eastern Pa. W-92.

Engineer, six to 12 years' experience for engineering water works pump-station equipment; pumps, piping, electrical, wells, etc. $7000, and up. Philadelphia, Pa. W-86(*b*).

Project Engineer, graduate, five to ten years' experience on machine design, particularly on automatic machine design and automation as used in food handling. Must be creative. To $15,000. Conn. W-81.

Mechanical Engineer, graduate, to work in expanding mining and metallurgical plant, experience in layout, installation, and maintenance. Opportunity for promotion available. South. W-75.

Engineers. (*a*) Quality engineer, administrator, to initiate and conduct programs in quality control; will have complete responsibility for one of three phases; i.e., machine products, terminal products, or wiring devices. To $9500. (*b*) Methods engineer, IE degree, experience in cost reduction, material handling, or packaging desirable, to initiate and develop programs and to present proposals. $9000–$12,000. Western Pa. W-72.

CANDIDATES FOR MEMBERSHIP AND TRANSFER IN ASME

THE application of each of the candidates listed below is to be voted on after April 24, 1961, provided no objection thereto is made before that date and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the Secretary of The American Society of Mechanical Engineers immediately.

New Applications and Promotions

Alabama

FRAZIER, MAURICE H., Florence

California

ASHWORTH, CLINTON P., San Francisco
●BROWN, FAYETTE, Chico
●DAVIES, ROBERT W., San Diego
HENDERSON, LEE A., Hayward
●KURZ, GERHARD H., San Diego
MILLMAN, VICTOR, San Diego
RETHWISCH, LLOYD E., Anaheim

Colorado

BERKOWITZ, HARVEY M., Littleton
●HONAKER, CHARLES M., Greeley
●MAXWELL, JOHN W., Wheat Ridge

Connecticut

GAMMELL, LEWIS W., Monroe
●HEIM, ARTHUR I., JR., Shelton
JENSEN, JORGEN F., Bridgeport
●MITCHELL, JAMES R., Seymour
STRONG, PHILIP M., Torrington
ZIERMANN, HERMANN, Cheshire

Florida

ROWLEY, WILLIAM K., Indian River City

Georgia

FOFFESTER, ROBERT H., Savannah
●HAY, ARTHUR L., JR., Savannah

Illinois

BARTS, EDWARD W., Glen Ellyn
BECKER, BERNARD M., Des Plaines
DANES, JOSEPH E., Westmont
FISHER, GERALD, Wilmette
GANN, OTIS L., Decatur
HENKEL, JAMES A., Chicago
HENSGEN, BERNARD T., Highland Park
●HESEMANN, GILBERT A., Decatur
LUCAS, PAUL A., Berwyn
SOIYA, GEORGE W., Chicago
●VELTROP, JAN A., Lombard
VISUVANATHAN, SINNATHAMBY, Argonne
●WESSLING, KENNETH F., Arlington Heights

Indiana

DELAO, MARTIN M., Indianapolis
MARKS, ROBERT T., Evansville
●NOTTOLI, GENE A., Munster

●Transfer to Member or Affiliate.

Iowa

●BLESSIN, FRED K., Davenport
GASKILL, LAURENCE R., Cedar Rapids

Kentucky

KONKEN, NORMAN D., SR., Louisville

Louisiana

BUSCH, COURTNEY C., Metairie
POWER, JAMES L., Zachary

Maryland

●HENDRICKSON, OLE Q., Reisterstown
SMITH, GEORGE J., Baltimore

Massachusetts

AYERS, ELWYN E., Beverly
BRALLA, JAMES G., Springfield
FLOSS, SIMON W., Belmont
●HIRSCH, CHARLES E., Marblehead
●SMITH, GLENN L., Springfield

Michigan

CIESLIK, BENJAMIN J., Detroit
●HORLDT, HENRY B., Detroit
KIDDER, GERALD F., Jackson
●MILLER, ALBERT S., Saginaw
ROHN, WILLIAM L., Jackson
SUNDSTROM, RAUL D., Kingsford

Minnesota

MACHLICA, JOSEPH E., Rochester

Missouri

MALSTROM, HAROLD D., Florissant

New Jersey

BAILEY, WAYNE D., Newark
●BODFISH, GEORGE H., Maplewood
CARPENTER, HARRY E., West Caldwell
CIRILLO, ANTHONY J., Camden
●DICKIE, ROBERT J., Maywood
JORDAN, MICHAEL, Orange
MONK, IVAN, Trenton
PETT, JOHN F., Westfield
SMYTHE, BERNARD T., Atlantic City

New Mexico

●HARDGRAVE, JACK M., University Park
REED, RAY P., Albuquerque
WHITAKER, WILLIAM E., Silver City

New York

ABEL, JACK, Bayside
DIVNEY, JAMES M., Hartsdale
FAHRNEY, WILLIAM E., Wellsville
KILLABY, DONALD B., SR., Rochester
KUO, CHI SHENG, Yonkers
MARUGGI, EDWARD A., Rochester
NEELY, RICHARD J., Wellsville
●OAKLEY, DAVID J., Schenectady
●OWENS, RAYMOND L., Clarence
PARRISH, PAUL E., Ballston Lake
ROWEN, WILLIAM I., Schenectady

Ohio

BRYANT, GORDON B., Cuyahoga Falls
COAN, RICHARD L., Maple Heights
COFFIN, LAURENCE H., Silver Lake
COLE, LYNN H., Tiffin
FILMER, ROBERT W., Oxford
KOHLES, WERNER H., Worthington
TAYLOR, RAYMOND H., Cincinnati
WILLIS, JOHN W., JR., Dayton

Oklahoma

GERE, JOHN L., Oklahoma City

Pennsylvania

AMBRO, GEORGE W., Erie
BARTH, EUGENE W., Verona
JOHNSTON, WILLIAM D., Erie
JOHNSTONE, DAVID K., Conshohocken
MAEDEL, PAUL H., JR., Broomall
TWELLS, DOUGLAS S., Drums
WILGUS, WALTER S., Greensburg

Rhode Island

RICHARDSON, PETER D., Providence

South Dakota

TSAO, KEH CHENG, Rapid City

Tennessee

●ABRAHAMSEN, ROY F., Chattanooga
●SPANN, DONALD E., Kingsport
●BARTO, JOHN L., Seymour
BRACE, ROBERT S., Memphis
WHITE, JOE D., Knoxville

Texas

ARISCO, ANTHONY J., Groves
BURKETT, ELDREADGE L., Baytown
FORNEY, ROSS H., Dallas
HODGEMAN, HERBERT H., Houston
JOOR, WILLIAM E., 2ND, Houston
UHR, JOHN I., El Paso

Utah

●PARKS, HENRY S., Salt Lake City
SEIDNER, LOYAL E., Brigham City

Virginia

PEEPLES, JACK Q., JR., Roanoke
PRITCHARD, WENTON M., Norfolk

Washington

EDTL, LELAND F., Richland

Foreign

AL-ID, NEMA K., Baghdad, Iraq
CHORLEY, GEORGE W., London, Ont., Canada
HARRIS, ELTON L., Edmonton, Alta., Canada
HOUGHTON, ARTHUR F., Somerset, England
KAMLANI, MOHAN V., Roorkee, U. P., India
KURAN, ALBERT A., Beirut, Lebanon
SUBRAMANIAN, K. V., Coimbatore Dt. Madras State, India
●STYLIANIDES, ARISTOTLE N., Nicosia, Cyprus
WALDRON, CHRISTOPHER, Pinner, Middlesex, England
WILSON, JAMES, Toronto, Ont., Canada

C. D. Howe, Engineer, Statesman, Businessman—1886–1960

Rt. Hon. Clarence Decatur Howe, revered as the "unquestioned architect" of Canada's modern economy, died Dec. 31, 1960, at his home in Montreal. For several decades one of Canada's most dominant political figures, Mr. Howe was often called the "minister of everything," a nickname that grew out of a career crowded with cabinet posts and political ventures in a multitude of fields. In one 15-month period during the Korean War, when he was charged with Canada's rearmament program, newspapers recorded his activities in housing, commercial research, industrial design, wheat sales, oats production, uranium, steel production, aluminum, war mobilization generally, labor unrest, industrial expansion, credit restrictions, import restrictions, shipbuilding, trade, production of the F-86 Sabre jets and the CF-100 fighters, automobile sales, and newsprint. During that time, he also had an audience with the late Pope Pius XII, visited the U. K. and the U. S. A., and defended himself several times against Conservative charges that he was a "dictator."

He presided with the greatest powers ever held by any Canadian in such a position, over the nation's transition from a largely agricultural country to a predominantly industrial one. He was the right-hand man of two Liberal Prime Ministers—Mackenzie King and Louis St. Laurent. It was said that he probably exercised from day to day greater power than either prime minister.

An engineer and a millionaire, he was responsible for building Trans-Canada, the country's national airline, and CBC, the government-owned radio and television system. He was in charge of Canada's World War II production effort.

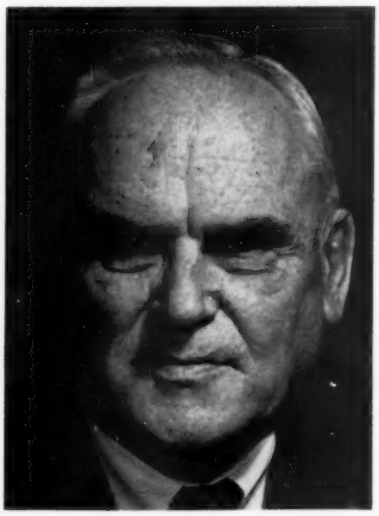
A native of Waltham, Mass.—where he was born on Jan. 15, 1886—Mr. Howe became a Canadian citizen in 1913, but retained New England qualities in the hustle and bustle of Canadian life. He was famed for a "down-East memory" for facts and faces, and, while easy-going, was brusque enough at times to gain the nickname of "granite face."

Mr. Howe was graduated as a civil engineer in 1907 from the Massachusetts Institute of Technology—and was one of its governors at the time of his death. He went to Canada in 1908 on the invitation of Dalhousie University, Halifax, to accept a post as professor of civil engineering at $2000 a year.

In 1912, when the Canadian government wanted a terminal grain elevator designed, the young professor at Dalhousie was asked to undertake the task. He went on from there to become a foremost designer and builder of grain elevators in North America. When the Board of Grain Commissioners was formed, in 1914, he moved to Port Arthur and became its chief engineer at the age of 28. He designed most of the government's grain elevators, inventing most of the machinery used in them, such as the extraordinary car dumpers. It was his royalty on these patents that made him a millionaire before he was 40. In 1916, he organized his own engineering firm, C. D. Howe and Co., Port Arthur, which was responsible for many large-scale construction projects, including elevators, docks, and pulp mills, in all Canadian provinces, the U. S., and Latin America. He acquired an international reputation as a builder of grain elevators and storage facilities, resulting in his services being secured by a British financial group as an adviser on grain storage in Argentina. For a year and a half, he worked on projects in Argentina, but was not forgotten by his fellow citizens in Port Arthur, who nominated and then elected him, in 1935, to represent them in Parliament. Prime Minister W. L. Mackenzie King, attracted by Howe's almost encylopedic knowledge of Canadian economy, included him in the cabinet as Minister of Railways and Canals and Minister of Marine. In this double capacity, Howe succeeded in uniting under one department all existing governmental transportation agencies and directing them in a new post as Minister of Transport.

At the outbreak of World War II, Howe was drafted by the Canadian government to head the War Supply Board, whose work he expanded so rapidly that it became the separate department of munitions and supply. As Minister of Munitions and Supply, he made all war purchases and directed war construction projects. In less than a year, he supervised the spending of more than $200 million on capital equipment needed to increase production, and approved nearly $1 billion worth of orders for Canada and the U. K.

Rt. Hon. C. D. Howe



His critics were sharp, calling him a "czar" and a "dictator," but Prime Minister King, who was a skilled and cautious politician, trusted him implicitly. Howe believed in getting things done, and did not care much whether there were people who disliked it or not.

"Perhaps I get overenthusiastic about a project," Mr. Howe once said. "I have been working on sizable projects all my life and somehow I reach a point in the development when I think a project is important and if it is a serious enough project, I begin to think it is the most important thing in the world." It was in this spirit that he created Trans-Canada Air Lines, reorganized the old Canadian Radio Broadcasting Commission into the present CBC, launched the atomic energy program, created the present National Harbors Board from smaller ones scattered across the country, and organized the Polymer Corp. He encouraged the formation of the A. V. Roe Co. at Malton, Ont., and was responsible for Canadair's development there through the sale of war factories to the Electric Boat Co. (later General Dynamics).

As Minister of Reconstruction and Supply after the war, Howe directed Canada's postwar industrial rise. From 1948 to 1951, he was Minister of Trade and Commerce. He was Canada's atomic energy chief as Minister of Defense Production from 1951 to 1957, when the Liberals were defeated and he retired from politics.

At the time of his death, he was chairman of the board of Ogilvie Flour Mills Co., Ltd., and a director of Consolidated Bakeries of Canada, Ltd., and several other tremendous industrial combines.

He was a member of the Imperial Privy Council, carrying the designation Right Honorable. In 1947, the U. S. Government awarded him the Medal for Merit. He was appointed Chancellor of Dalhousie University in 1957. His name is preserved there in the Rt. Hon. C. D. Howe chair of engineering. He held 15 honorary degrees in law, science, and engineering from universities in Canada, the U. S. A., and Australia. He was an Honorary Member of The American Society of Mechanical Engineers since 1941. He received the Daniel Guggenheim Award in 1954 and the Herbert Hoover Medal in 1952. He was an honorary member of the Engineering Institute of Canada.

Surviving are his wife, the former Alice Worcester, daughter of his first employer in Boston; sons, William and John; and daughters, Elizabeth, Barbara, and Mary.

OBITUARIES

Jerome Bartels (1913–1961), professor of mechanical engineering, Polytechnic Institute of Brooklyn, died, Brooklyn Hospital, Jan. 2, 1961. Born, New York, N. Y., March 1, 1913. Parents, Mr. and Mrs. Abraham Bartels. Education, BME, CCNY, 1946; MME, New York Univ., 1948. Mr. Bartels was an expert in the field of heat-power applied to atomic energy. He had been with Polytechnic for 12 years. During that time, he also was associated with a number of industrial companies. He was a power-plant consultant to Gibbs and Hill, Inc., 1951–1956; and Carlson and Sweatt, 1957–1958. For several summers, he also worked with the Turbo-Generator Division of the General Electric Co., Schenectady, N. Y. In addtion to his regular consulting duties, he was a partner in the consulting firm of Peterson and Bartels from 1948 to 1951. For six years, beginning in 1940, he worked in the engineering design office of the New York Naval Shipyard in Brooklyn. He taught at New York University from 1946 to 1948. He authored many articles on thermodynamics, including a contribution to the *Transactions of the ASME*, July, 1955. Mem. ASME, 1946. Committee service in ASME included membership on the Program Committee of the Metropolitan Section, 1953–1955; chairmanship of that committee in 1955; and a period that same year as Diamond Jubilee Lecturer of the Pittsburgh Section. He held membership in ASEE, SAE, and Sigma Xi, and was an honorary member of Pi Tau Sigma. He was a registered professional engineer in New York. Survivors include his wife, the former Mollie Ohr; a son, Robert; a daughter, Laura Marie; his parents; a brother, Stanley L.; and a sister, Mrs. Charlotte B. Smirnoff.

Rudolf August Beyer (1892–1960), internationally known teacher and research worker in the analysis, synthesis, and kinetics of linkages; professor, Technische Hochschule, Munich, Germany, and visiting professor of mechanical engineering; Yale Univ.; died, Nov. 27, 1960. Born, Kaltofen, Saxony, Germany, May 18, 1882. Parents, Mr. and Mrs. Hermann August Beyer. Education, PhD, Univ. of Leipzig, Saxony, 1918; Dr. Phil. Habil., Technische Hochschule, Dresden, 1939. Dr. Beyer was a noted teacher, researcher, and author. He wrote seven books on kinematics and dynamics of mechanism, and 90 scientific papers, and was the organizer and technical editor of *Getriebetechnik*, the first regularly published journal devoted to mechanisms, which he started in 1933. He served in both world wars. After World War I, he was appointed a lecturer in mathematics, mechanics, and kinematics at the Engineering School of Zwickau, Saxony, also teaching at the Zwickau high school. He became vice-principal of the engineering school in 1938. Soon afterward, he was awarded the title Dr. Phil. Habil., for a paper entitled "Synthesis of Plane and Space-Mechanisms," and was thereafter entitled to lecture in the faculty of mechanical engineering at the Technische Hochschule in Dresden, an activity he was forced to discontinue when World War II interrupted his academic work. From 1939 to 1945, he was a major in the Signal Corps of the German Army. He settled in Munich after the war to work with the U. S. Army of Occupation as chief of a German engineering battalion, and then returned to teaching in 1948 as a lecturer at the Oscar V. Miller Polytechnic School in Munich. He also lectured at the technical university there. In 1954, the university appointed him professor for kinematics and adjunct professor for kinematics and mechanisms. Throughout most of his career, Dr. Beyer did consulting work for industrial concerns. He was an expert in patent suits. Two years before his death, he visited the U. S. on a nation-wide tour as a Fulbright lecturer, and was appointed a visiting professor of mechanical engineering at Yale University. His books on kinematics include "Introduction to Kinematics," 1928, "Technical Kinematics," 1931, "Synthesis of Plane Mechanisms," 1953, and "Elements of Space Mechanisms," 1953. Mem. ASME, 1959. Under his leadership as a member of the German Engineering Society (VDI), the VDI-AWF Handbook of Mechanisms published a leaflet series entitled *VDI-Richtlinien*. He was co-editor of handbooks on applied mechanics and contributor of many published scientific papers and technical articles on kinematics of plane and space mechanisms (analysis, synthesis, statics, and dynamics). He delivered lectures in theoretical and applied kinematics at scientific sessions of technical societies, including VDI, Society of Applied Mathematics and Mechanics as well as at colloquiums of the Universities of Leipzig and Riga.

Darrel Calvin Borden (1924–1960), principal engineer, Systems Engineering Division, Battelle Memorial Institute, Columbus, Ohio, died, Nov. 15, 1960. Born, Akron, Ohio, Oct. 10, 1924. Education, BME, Ohio State Univ., 1948. Mr. Borden was with Battelle Memorial Institute since 1956. He had previously worked as a development engineer with Goodyear Aircraft Corp., Akron, Ohio, from 1948 to 1954; and as designer with Pratt & Whitney Aircraft, Hartford, Conn., from 1954 to 1956. Assoc. Mem. ASME, 1949.

Robert E. Cecil (1880–1960), retired engineer, formerly vice-president of Scaife Co., Oakmont, Pa., died, Dec. 12, 1960. Born, Pulaski, Va., July 1, 1880. Education, BS, Virginia Polytechnic Institute; ME. Mr. Cecil designed and built many types of machinery and structures, particularly pressure vessels. During World War II, he was an outstanding participant in the design and fabrication of shells for the U. S. Government, and developed procedures for manufacturing such pressure vessels, particularly methods for pulsating pressure tests. For this work he was cited by the government. At the beginning of his career, Mr. Cecil was a draftsman and designer for several companies, although spending most of that time with the American Bridge Co. In 1913, he joined the Air Tight Steel Tank Co., Pittsburgh, Pa., as chief engineer, rising to the position of vice-president and general manager in 1917. Later, he joined the Scaife Co. He held a number of patents, several of which pertained to machinery embodying a principle new in the early 1900's of spraying fruit trees, for which machinery he won several awards. Mem. ASME, 1921. Mr. Cecil was elected an honorary member of the ASME Boiler and Pressure Vessel Committee in 1954. He was a member of the committee since 1932, contributing to its work and to that of several of its major subcommittees, including the Subcommittee on Welding, the Procedure Subcommittee of the Joint Research Committee on Welding of Pressure Vessels, the Subcommittee on Unfired Pressure Vessels, the Boiler Code Main Committee, the Subcommittee on Special Design, the Special Committee on Braising, the API-ASME Committee on Unfired Pressure Vessels, and the Subcommittee on Rules for Dished Heads.

Dwight Robertson Collins (1902–1960?), mechanical engineer, Denver and Rio Grande Western Railway, Denver, Colo., died recently according to a notice received by the Society. Born, Goldfield, Colo., May 18, 1902. Education, high school. Mr. Collins was an air-brake specialist. He serviced that type of equipment for the Westinghouse Air Brake Co., Wilmerding, Pa., for many years, beginning in 1930, supervising its installation and maintenance on railroads and public-transportation systems. During the preceding decade, he worked in the mechanical department of the Denver and Salt Lake Railway. Mem. ASME, 1942.

George Merrick Dusinberre (1899–1960), professor of mechanical engineering, Pennsylvania State Univ., University Park, Pa., died, Dec. 30, 1960. Born, Edgewood Park, Pa., Jan. 30, 1899. Parents, George Brown and Louise (Merrick) Dusinberre. Education, BS, U. S. Naval Academy, 1919; MS(ME), Columbia Univ., 1926. Married Charlotte Heath, 1930; children, William Warner and Nancy Dusinberre. A teacher of mechanical engineering for most of his career, Professor Dusinberre's contribution to mechanical engineering, both professionally and academically, was impressive. A major contribution was his book, "Numerical Analysis of Heat Flow," McGraw-Hill, 1949, which has been widely used by practicing engineers in the mechanical and chemical industries. He was a professor at the Pennsylvania State University since 1948. In previous years, he held the same position at the University of Delaware, and taught thermodynamics and heat transfer at the Virginia Polytechnic Institute, Blacksburg, Va. As an instructor at the U. S. Naval Academy from 1919 to 1939, he contributed greatly to the writing of a thermodynamics text used at the Academy since 1937. Returning there in 1940, after a period at Virginia Polytechnic, he had charge of planning courses of instruction for last-year students and selecting and supervising instructors at the Academy until 1946. He also initiated instruction there in gas turbines. He authored several papers and a book, "Gas Turbine Power," 1952. He contributed a chapter titled "Two Problems in Building Heating Solved Numerically" to the book "Numerical Methods of Analysis in Engineering," published by Macmillan in 1949. At the time of his death, he was working on galley proof for a new book "Heat Transfer Calculation by Finite Differences," to be published this year by International Textbook Co. Mem. ASME, 1938; Fellow ASME, 1954. An internationally recognized authority in the heat-transfer field as the result of his numerous activities and publications, he was in constant demand as a lecturer. Professor Dusinberre organized the National Heat Transfer Conferences, and was chairman of the committee for the first Conference held at the Pennsylvania State University. He also is credited with starting the idea of the Second International Heat Transfer Conference, to be held in Boulder, Colo., in August, 1961. He was chairman of the Papers Committee of the Heat Transfer Division for two years, and a member of the Division's Executive Committee. He also was a member of the Executive Committee of the ASME Central Pennsylvania Section. He held membership in ASEE, Pi Tau Sigma, and Sigma Xi, and was a registered professional engineer in Maryland.

Samuel Otto Fischman (1911–1960), president, Century Equipment Co., Chicago, Ill., died, Dec. 1, 1960. Born, Odessa, Russia, March 15, 1911. Parents, Oscar and Fannie Fischman. Education, BS(ME), Univ. of Illinois, 1933; attended Illinois Institute of Technology. Naturalized U. S. citizen, Camp Custer, Mich., 1918 (derived from father). Married Joan Leader, 1936; daughter, Anice Marylin Fischman. Mr. Fischman possessed a thorough knowledge of machines and machine tools used in manufacturing a variety of metal and wood products. He worked for a number of companies in Illinois as a research engineer, plant manager, and designer from 1933 to 1935. Then he became plant manager of the Century Store Fixture Co. in Chicago, and from 1937 to 1939 was designer, and plant and production engineer for the Century Cabinet and Fixture Co., working on machinery for the manufacture of interior woodwork and equipment for stores and institutions. He also worked for a period in Chicago's Department of Subways and Superhighways as a field engineer on subway construction. In 1940, he became an inspector of mechanical-engineering materials with the Navy Department's Field Inspection Service, and one year later was an assistant mechanical engineer under the Chief of Operations and Engineering at the Elwood Ordnance Plant in Joliet, Ill. He also spent several years as a senior process engineer with the Illinois Division of the Bendix Aviation Corp., Chicago. He held a Federal civil service rating of mechanical engineer. Assoc. Mem. ASME, 1933. He was a member of Pi Tau Sigma.

Oliver J. Haller (1883–1960), project engineer, Pittsburgh Piping and Equipment Co., Pittsburgh, Pa., died, Nov. 30, 1960. Born, Pittsburgh, April 24, 1883. Education, ME, Lehigh Univ., 1904. A specialist in power piping, Mr. Haller was a draftsman with the American Locomotive Co. in Pittsburgh before going with the American Foundry and Construction Co. in 1905. Between then and 1924, he held successive positions there, beginning as a draftsman and proceeding to assistant mechanical engineer, mechanical engineer, erection superintendent, and then general superintendent and director. In 1929, he became a power-plant designing engineer and service consultant on power-plant piping problems, working with the Pittsburgh Piping and Equipment Co. Mem. ASME, 1936. He was a member of Tau Beta Pi.

Samuel Ketchum (1879–1960?), retired engineer, died recently according to a notice received by the Society. Born, Montclair, N. J., Nov. 14, 1879. Parents, William H. and Ella (Goman) Ketchum. Education, ME, Stevens Institute of Technology, 1902. Married Alice A. Hope, 1921. Mr. Ketchum spent 27 years with the M. H. Treadwell Co. in New York City. As chief draftsman, he designed special heavy machinery, and in 1916 became a mechanical engineer in charge of the drafting department. He left there in 1933, and a short time later joined the Carrier Engineering Corp., Newark, N. J. He continued in the drafting department there until 1946, when he went to work with the Aerofin Corp., Syracuse, N. Y. He retired in 1950. Assoc.-Mem. ASME, 1908; Mem. ASME, 1917. Committee work in ASME concerned standards for drawings and drafting practice. He was a registered professional engineer in New York State.

Martin Benjamin MacNeille (1887–1960), manager, Pump Div., A. Y. McDonald Mfg. Co., Dubuque, Iowa, died, May 19, 1960. Born, Camden, N. J., August 21, 1887. Parents, Martin Cox and Ida E. MacNeille. Education, ICS, Alexander Hamilton Institute, and self study. Married Lillian Martin, 1915. Mr. MacNeille, a specialist in centrifugal pumps, joined A. Y. McDonald Mfg. Co. in 1943. He had behind him at that time a record of 31 years with the Fairbanks Morse and Co., Beloit, Wis., where he had worked steadily since 1912, with the exception of short periods with two other companies. With Fairbanks Morse, he had been chief engineer of the hydraulic department in the Three Rivers, Mich., plant, before heading the company's pump division. Mr. MacNeille's early experience was gained chiefly with the Watson Stillman Co., New York, N. Y., where he was from 1907 to 1912. Between 1917 and 1923, he also was vice-president of the Beloit Building and Loan Association. His inventions included hydraulic balance of centrifugal pumps, special pump bearings, hydraulic seal plugs, telescopic shaft-protecting sleeves, and hydrojet combination interchangeable deep-well and shallow-well pumps. He authored numerous trade paper articles on pumps. Mem. ASME, 1921. He did

work on the ASME Power Test Codes Committee and was chairman of Committee No. 8 on the Centrifugal and Rotary Pump Test Code in 1936. He was a member of the ASME Old Guard. He was president of the Hydraulic Institute in 1930, and a member of TAPPI and the American Water Works Association.

Lorne Douglas McMulkin (1923–1960), senior design engineer, Convair Division, General Dynamics Corp., Pomona, Calif., died, Sept. 29, 1960. Born, Alliston, Ont., Canada, Oct. 13, 1923. Education, BASc(ME) Univ. of Toronto, 1951. Before joining General Dynamics Corp., Mr. McMulkin worked first with the National Iron Corp., Ltd., Ontario, as a draftsman, and then with the Algoma Steel Corp. Ltd., in Sault Ste. Marie, Ontario, as a junior engineer. Assoc. Mem. ASME, 1952. He was a member of the Association of Professional Engineers. He is survived by his wife.

Robert Gilson Nye (1880–1960?), retired mechanical engineer, died recently according to a notice received by the Society. Born, Syracuse, N. Y., June 21, 1880. Parents, Francis H. and Frances E. (Avery) Nye. Education, ME, Syracuse Univ., 1910. Married Miss Gibson, 1906; children, Velma G., Frances R., Robert G., Jr., and Carroll H. Nye. Mr. Ny worked with Buffalo Pumps, Inc., Tonawanda, N. Y., for a number of years, beginning in 1916. He became a factory manager and director there in 1922. He had previously been assistant superintendent and factory manager with the Buffalo Forge Co., Buffalo, N. Y., where he had started as chief draftsman in 1910. Mem. ASME 1912. He was a past-chairman of the Buffalo Section of ASME, and had served as a member of the ASME Nominating Committee. He was a past-vice-president of the Engineering Society of Buffalo.

Oscar Einar Pederson (1913–1960?), chief engineer, Flint Steel Corp., Tulsa, Okla., died recently according to a notice received by the Society. Born, Galveston, Texas, Jan. 26, 1913. Education, BS, Oklahoma State Univ., 1936. Mr. Pederson was chief engineer with Flint Steel Corp. since 1937. He supervised all design and estimating of pressure vessels, structural buildings, and transmission towers. Mem. ASME, 1959. He was a member of the Oklahoma Society of Professional Engineers and NSPE, and was a registered professional engineer in Oklahoma.

Bayard Edwin Richardson (1889–1960), president and treasurer, Nucraft Furniture Co., Grand Rapids, Mich., died, July 13, 1960. Born, St. Johns, Mich., Feb. 16, 1889. Parents, Edwin Carlton and Elizabeth (Eckert) Richardson. Education, attended Univ. of Michigan. Married Amy L. Van Every, 1911; children, Bayard E., Jr., and Curtis V. E. Richardson. Married 2nd, Lucina Taylor, 1946. Mr. Richardson organized the Products Engineering Service and Nucraft Furniture Products, both in Grand Rapids, in 1934, to exploit his many personally owned patents on desks, cabinets, and combined steel and wood furniture construction for mass production. Worker in steel erection. Mr. Richardson was a specialist in aeronautics in the early 1900's. He built three Bleriot-type airplanes, all of which flew successfully. He also spent a few years doing design work with the Grand Rapids Show Case Co. and the Wilmarth Show Case Co. Then he organized the Mechano Gear Shift Co. in Grand Rapids in 1913, and as chief engineer of product design on automobile accessories, worked on automotive transmission, gearing, free-wheeling, and automatic gear-shifting devices in the experimental departments of Buick, Willys Overland, Dodge Bros., and other companies. He entered the furniture business in 1922 as chief engineer of Stow Davis Furniture Co., taking a similar position a decade later with Gunn Furniture Co., both in Grand Rapids, where he eventually formed his own organizations. He held 37 patents in auto devices, and 12 in the office furniture field. Mem. ASME, 1929. He authored a paper on "Problems of Design for Mass Production in the Furniture Industry," published in the *Transactions of the ASME*. He held membership in the Wood Office Furniture Institute, the Grand Rapids Engineers Club, the Michigan Engineering Society, the American Ordnance Society, and the American Institute of Economic Research.

Theodore Hamilton Robinson (1898–1960), consulting mechanical engineer, died, July 8, 1960. Born, New York, N. Y., Nov. 9, 1898. Education, attended Stevens Institute of Technology. A designer of special machinery, Mr. Robinson had a varied career dealing with many types of products. He started as a machinist with several companies, including the Thomas A. Edison Laboratories, West Orange, N. J., and then became a draftsman with the Submarine Boat Corp., Port Newark, N. J. From 1920 to 1922, he was with the Westinghouse Lamp Co., in Bloomfield, N. J., doing specification work on lamp-making machinery, but in the latter year moved on to design special machinery for The Celluloid Co. in Newark, and still later for the Pyrene Mfg. Co. Moving into a supervisory capacity in 1926, he took a position as New York branch manager with The Herman Nelson Corp., Moline, Ill., where he worked to further the engineering applications of heating and ventilating equipment. He became proprietor for Robinson Bros., a Jersey City firm, in 1930. During the latter part of the war, he was a chief engineer with the U. S. Army Transport Service, working on the maintenance of gasoline-propelled rescue vessels in the Atlantic and Pacific theaters. After the war, he took up his own consulting practice, working out of Jersey City and later in New York. Mem. ASME, 1950. He was a member of the Montclair (N. J.) society of Engineers, the Society of American Military Engineers, and NSPE, and was a registered professional engineer in New Jersey.

John J. Russell (1893–1960), principal assistant pipe superintendent, Benjamin F. Shaw Co., Wilmington, Del., died, August 25, 1960. Born, Glens Falls, N. Y., July 13, 1893. Education, high school. Mr. Russell worked on mechanical equipment for buildings, including power plants, boiler plants, refrigeration, heating, and air-conditioning projects. He worked for such companies as the Goodyear Tire and Rubber Co. in Akron, Ohio, as an engineer on power-plant construction; and the Kirmear and Russell Co., Akron, as an estimator and supervising engineer on power plants and piping projects for many firms, including the B. F. Goodrich Rubber Co., and the Mason Tire and Rubber Co., Kent, Ohio. For the American Carbonic and Machinery Co., Wisconsin Rapids, Wis., in 1927, he had charge of field survey and erection of refrigeration and air-conditioning equipment, and for five years following that date was in charge of all mechanical work on the New York Telephone Building at Walker and Lispenard Streets for Marc Eidlitz and Son Co. Later, he also worked as a mechanical engineer for the Central Hanover Bank, New York City. Mem. ASME, 1933.

Ed Sinclair Smith (1897–1960), scientific and technical adviser, Weapon Systems Laboratory, U. S. Army Ordnance, Aberdeen Proving Ground, Aberdeen, Md., died, Johns Hopkins Hospital, Dec. 31, 1960. Born, Angola, Ind., March 28, 1897. Parents, Rev. Ed Sinclair and Helen Read (Kingsley) Smith. Education, BS, Univ. of California, Berkeley, 1919; ME, 1932. Married Adah Grace Fiske, 1929; children, Karyl Kinglsey, Helen Fiske, Claire Elizabeth, and Ruth Proctor. Mr. Smith gained professional recognition in hydraulic, control, and patent engineering. He was a pioneer in fluid metering. One of his engineering achievements was authorship of the book "Automatic Control Engineering," the first of its kind in English, published by McGraw-Hill in 1944. A registered patent agent, much of his business activity was as liaison between the engineering and patent fields. Mr. Smith acquired experience with several companies from 1919 to 1923, chief among them the Standard Oil Co. of California, the Pacific Gas and Electric Co., and the Shell Petroleum Co., all in California. He moved to the East Coast in 1923 to take a position as assistant chief engineer with Builders Iron Foundry, Providence, R. I., later working as a hydraulic, and then a patent engineer. Then he spent several years with the C. J. Tagliabue Mfg. Co., Brooklyn, N. Y., in charge of company patents, and as a consultant on flow and controlling problems. With several other companies before the war, he consulted on carburetors and flow meters. During World War II and until 1948, Mr. Smith was employed as a research engineer in automatic control by the Bendix Aviation Corp., Teterboro, N. J. His work included the development of stabilizing suction relief valves for fighters and superchargers for bombers. Later, he served as a patent liaison engineer. Among his other contributions to the war effort were the building of a five-in. naval ammunition hoist, porosity meters for parachute fabric, scoops for bomber carburetors and for naval vessls, and essential hydraulic components for Pearl Harbor dry dock reconstruction shortly after the start of the war. More than a dozen different devices were patented by Mr. Smith, who also authored numerous technical papers, many of them for ASME, and a treatise entitled "Binomial, Normal, and Poisson Probabilities." Assoc.-Mem. ASME, 1923 Mem. ASME, 1931 Fellow ASME, 1946. Mr. Smith was one of the founders of the ASME committee that later became the Instruments and Regulators Division. He was its first chairman. In 1954, he received the Division's annual award, presented for outstanding contributions in instrument and regulator research and development. One of his research papers on fluid metering won him the ASME Junior Award in 1931. He also did work on the Fluid Meters Committee, and the Drafting Standards Committee. He was a member of Sigma Xi, the New York Society for Measurement and Control, the Instrument Society of America, and the New Jersey Patent Law Association. He was a registered professional engineer in New York. Surviving are his wife, Adah; four daughters; a sister, Mrs. Helen Yates of California; and five grandchildren.

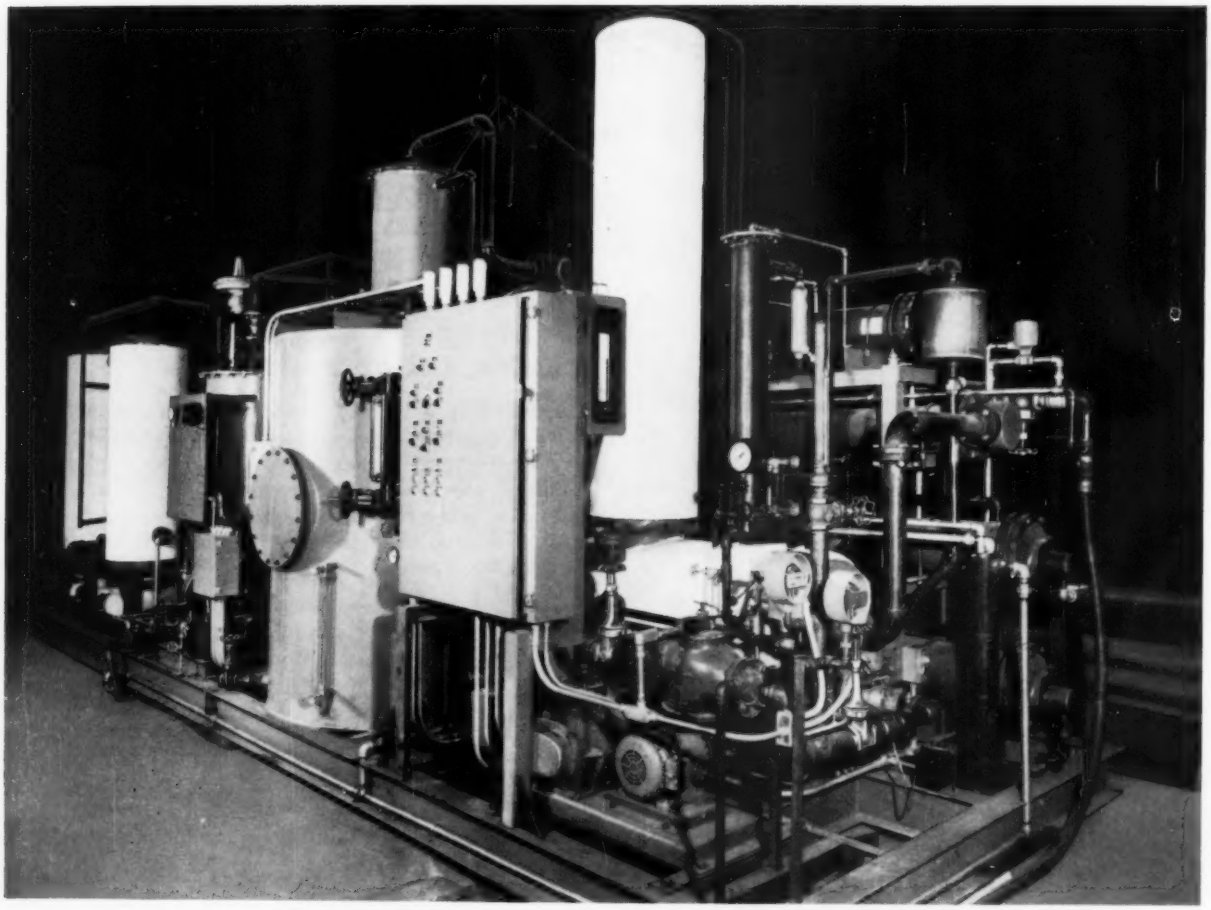
Kalman Steiner (1902–1960), vice-president, Central Fuel Co., Baltimore, Md., died, Dec. 6, 1960. Born, New York, N. Y., Nov. 9, 1902. Parents, Lajos and Rebecca Steiner. Education, BS, Illinois Inst. of Technology, 1924; ChE, 1928. Married Ruth Kawin, 1927; children, William K. and Thomas P. Steiner. A technical writer as well as an engineer, Mr. Steiner authored and coauthored about 40 articles for technical engineering journals, and several books, chiefly on fuel oil and oil burners. He devoted most of his career to that field, beginning in 1928 with the Johnson Oil Burner Co., Chicago, on the installation and service of industrial oil burners. By 1931, he was a superintendent there, but left to go with the Consumers Petroleum Co., where he became supervising chemist and chief engineer, advising the company on the design and application of industrial oil burners. Subsequent positions included superintendent and chief engineer on boiler-plant oil-burner and gas-burner systems with the Mid-West Heat Service, Chicago; and general manager, including the preparation of technical manuals, with the Ace Engineering Co. From 1942 to 1945, he was assistant chief of production for the Army Ordnance Department, in Chicago Ordnance District. Before going with the Central Fuel Co. around 1956, he was a consulting engineer with the C. Hoffberger Co., Baltimore, Md. He authored the book "Oil Burners," McGraw-Hill, 1937, and coauthored "Oil Burner Service Manual," 1942, and "Fuels and Fuel Burners," 1946. A member of the board of consulting and contributing editors of *Heating, Piping and Air Conditioning*, he contributed a number of book reviews to that publication. Mem. ASME, 1945. He was a member of the American Society for Testing Materials, and ASHRAE, and was a registered professional, chemical, and mechanical engineer in Minnesota.

Herbert Leslie Thompson (1884–1960), owner, H. L. Thompson Co., Houston, Texas, died, August 5, 1960. Born, Hokah, Minn., Jan. 8, 1884. Education, ME, Univ. of Minnesota, 1912. Mr. Thompson established his company in 1928, after more than a decade as a sales engineer in various locations in the U. S. and South America. In 1909, he went to work for the Tobasco Plantation Co. on its sugar plantation near Santa Lucrecia, Vera Cruz, Mexico. After several years working there on many types of machinery, including sugar-house, plantation-locomotive, wood-working, and ice machinery, malarial fever forced him to leave. Returning to the States, he finished his education, and then left again for location at Rio de Janeiro, Brazil, with the International Steam Pump Co., which later became the Henry R. Worthington Pumping Machinery Corp. During the following years, he held several positions with the Ingersoll-Rand Co., working out of company offices in New York, N. Y., St. Louis, Mo., and Houston, Texas. The company also sent him to Cuba in 1915 as a special representative to handle the pump business it was developing in the Cuban sugar houses. Mem. ASME, 1957. He was a member of the Texas Society of Professional Engineers, and the Houston Engineers Club, and was a registered professional engineer in Texas.

Eric Henry Wang (1906–1960), chief, Structures Division, Research Directorate Department, U. S. Air Force Special Weapons Center, Kirtland Air Force Base, Albuquerque, N. Mex., died, Dec. 4, 1960. Born, Vienna, Austria, May 5, 1906. Education, Ingenieur (Diploma Engineer), Technical Univ. of Vienna, 1935. Mr. Wang, a pioneer in AFSWC blast effects research, played a leading part in establishing the shock tube as an important blast-effects research tool. His contribution to the knowledge of blast effects is credited by the Research Directorate Department as a key factor in helping to develop ways and means of protecting Air Force installations from nuclear attack. He came to the Special Weapons Center in 1956, when the Structures Division was moved there from the old Wright Air Development Center in Ohio. He was a Federal employee for more than ten years. For nine years prior to his government service, he taught at the University of Cincinnati, beginning in 1943. During that time, he also was a member of the Cincinnati Planer Company's engineering department. At various times, he also was a consultant to the machine-tool industry. Mem. ASME, 1946. He was a member of the Engineering Society of Cincinnati, and the Ohio Society of Professional Engineers, and was a registered professional engineer in the State of Ohio. He is survived by his wife, Marie, and two daughters, Irene and Erika.

Frederick George Wilson (1896–1960), vice-president of manufacturing, Waterbury Company, Inc., Waterbury, Conn., died, March 16, 1960. Born, London, England, Jan. 17, 1896. Parents, George Alfred and Ellen (Wettone) Wilson. Education, graduate, Pratt Institute, 1924. Naturalized U. S. Citizen, Waterbury, Conn., May 18, 1938. Married Edith Reibold, 1928. Mr. Wilson went to work with the Waterbury Button Co., manufacturer of buttons and novelties, in 1924, as an estimator and production superintendent. Later, he became a metal sales manager with the company. His position as vice-president also concerned plastics. Before completing his education at Pratt Institute, he held several tool and gage-making positions with Massachusetts companies. Jun. ASME, 1924; Mem. ASME, 1935. He worked on the ASME Standards Committee.

"We Won't Take Chances with Customer Confidence..



...our Atmosphere Generator Systems incorporate JENKINS VALVES"

Gas Atmospheres, Inc., Cleveland

"A reputation for reliability has made us the largest exclusive producer of packaged gas systems for industry. Care in choosing our components has helped build that reputation. We incorporate Jenkins Valves in our systems because our customers know there's nothing better to be had." Gas Atmospheres, Inc. of Cleveland and scores of other producers of industrial equipment employ Jenkins Valves to prevent trouble and costly maintenance for their customers. At the same time, they build respect for the quality of their products.

Of course, valves of less quality can be had for a little less money. But the real money-saving truth is that Jenkins Valves, so widely known for reliability and long life, COST NO MORE than any good valves. Jenkins Bros., 100 Park Avenue, New York 17.

JENKINS

MOST TRUSTED TRADEMARK IN THE VALVE WORLD

VALVES

JENKINS SINCE 1864 Jenkins Bros

Sold Through Leading Distributors Everywhere

Circle No. 73 on Readers' Service Card

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Available literature or information may be secured by using convenient Readers Service Card on Page 149

NEW EQUIPMENT

Backing for Crusher Parts

A nonmetallic backing for manganese-crusher parts involving an entirely new method of application has been introduced by Nordberg Mfg. Co. The new backing agent, called "Nordbak," can be poured at "room temperature" without the special pouring equipment or precautionary measures usually associated with metallic-backing agents.

With Nordbak no special preparation of the wearing part or its mating member is necessary and intimate initial support of the manganese is provided. Mixing and pouring and accomplished at the crushing site.

Weighing only one fourth as much as metallic backing agents Nordbak is supplied in convenient, packaged kits. Kits include the base material in an expendable mixing bucket, a smaller can of blue liquid hardening agent and a sitrring tool. These kits may be stored, conveniently ready for use whenever and wherever needed. The only equipment necessary when preparing Nordbak for pouring is a power drill and the stirrer provided with each kit. When properly mixed, Nordbak is simply poured from the can into the mantle cavity, filling voids as narrow as $\frac{1}{8}$ in. No heavy, molten metal and no dangerous high temperatures are present. —K-1

Vertical Turbine Pumps

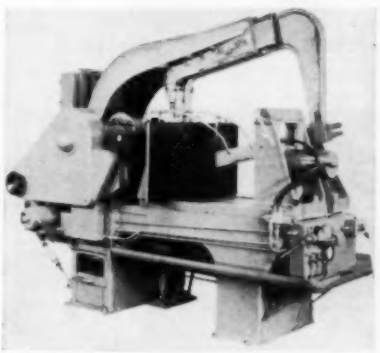
The vertical turbine pump, originally developed primarily for pumping from deep wells, has been recognized recently as also extremely well adapted to applications once considered the exclusive field of conventional horizontal pumps. Requiring a minimum of floor space, and possessing great flexibility for meeting changed operating conditions with minimum conversion expense, the close-coupled vertical turbine pump is today well established in industrial use.

In a well-illustrated catalog Fairbanks, Morse gives details of the vertical turbine pump as it is used in industry for high-pressure or low-pressure service; in standard close-coupled or in pot type, for conventional flow or inverted design. —K-2

Pneumatic Totalizer

B-I-F Industries has announced the addition of a panel-mounted pneumatic totalizer to its line of metering equipment. The pneumatic totalizer multiplies flow rate by time to give total flow. It receives a linear or square-root pneumatic signal between 3 and 15 psi and converts this air pressure into direct readout of total flow in volumetric units on a cyclometer-type totalizer.

Entirely self-contained, requiring only input air signal and electrical power connections, the pneumatic totalizer is only $7\frac{1}{4}$ in. wide × $7\frac{1}{4}$ in. high × 9 in. deep behind the panel which may be up to $\frac{1}{4}$ in. thick. —K-3



Metal Saw

A new heavy-duty hydraulic saw, Model 2424, becomes the largest in the metal saw line of Racine Hydraulics & Machinery, Inc. It will cut material up to 24 × 24 in. in size, or with 25 in. dia employing a 36-in. × $4\frac{1}{2}$-in. × 0.125 × 2T saw blade to obtain maximum capacity.

A 10-hp 4-speed Lima motor and a built-in three-speed gear box provide 11 variables in speed ranging from 12 to 145 strokes per min. The stroke length is 6 in. A feature of the machine is the adjustable pressure-type hydraulic feed with a range of 0 to 350 psi. A total downward pressure of approximately 42,000 psi can be applied with the double main cylinders. A heavy-duty hydraulic chuck cylinder, adjustable vertically, holds the workpiece.

In addition to meeting demands for saws of greater dimension, the new Racine model can be used in cutting high density alloys, or so-called "exotic" metals such as titanium, hastelloys, beryllium, or zirconium. —K-4

Multi-Bearing Takeup Frames

Link-Belt Co. new multibearing takeup frames, available from stock in 11 sizes, are especially designed to accommodate any type of bearing—babbitted, bronze, ball, or roller—in any two-bolt pillow block with mounting holes up to 5/8 in.

The new frames allow horizontal bearing adjustments from 6 to 24 in. and will mount 143 different bearing shaft sizes from 5/8 to $2\frac{7}{16}$ in. dia. Mounting pads are easily adjusted to the mounting holes in the pillow block. One pad is moved by an adjusting screw, while the other pad slides freely to the proper distance between the pillow-block mounting holes. This mounting flexibility permits each size of takeup frame to accept a wide range of pillow-block bore sizes. Mounting bolts are zinc plated and washers and nuts for mounting the pillow block are furnished with each frame.

Leaflet 2821, "Multi-Bearing Takeup Frames," contains additional information. —K-5

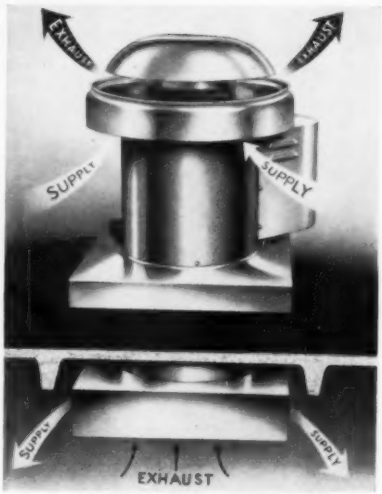
Chain Drives

Morse Chain Co., has developed chain drives for transmitting power of small gas-turbine engines of 30 to 1800 hp. These chains are applicable to main or auxiliary drives and are readily capable of transmitting rotating power between parallel shafts at high speed. Designated Hy-Vo (high velocity-involute sprocket), the new chain is a refinement of the silent-chain principle for extremely high speeds and heavy loads. It incorporates compensating links that fully eliminate chordal action normally encountered at very high chain speeds.

Hy-Vo was developed to fill the power-transmission gap between low-speed roller chain that is not applicable to gas turbines and high-speed gearing. Hy-Vo is unique in that it is the only mass-produced drive suited to gas-turbine power transmission. —K-6

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS



Combination Supply-Exhaust Fan

A single-impeller, package-type unit which provides both supply and exhaust simultaneously is announced by the Clarage Fan Co. The Twinalator is a unique dual-function unit and is well suited to a wide variety of applications in all types of buildings. With the new Twinalator, the fresh-air supply which is delivered under pressure by the unit can be directed by adjustable louvers at the unit or ducted to specific areas. This control assures maximum effectiveness and thus minimizes the air volume needed to accomplish specific results. At the same time the dual-function Twinalator draws exhaust air from the space and discharges it to the atmosphere outside the structure. Here, too, the air can be exhausted from under the roof or ceiling for general ventilation or it can be ducted a reasonable distance from specific sources to prevent contamination of the over-all area.

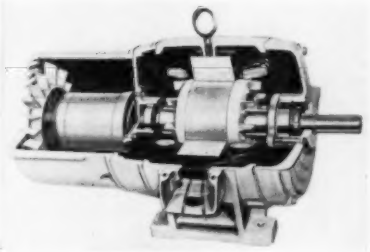
In addition to general ventilation, the Twinalator is well adapted to industrial ventilation. It is applicable for temperatures to 200 F and for gases and fumes.

The Twinalator is particularly suited to closed or semi-closed systems, such as laboratory hoods, commercial laundry machines, industrial metal cleaning, or any installation where supply and exhaust may be ducted in the immediate area of contamination.

Capacities, dimensions, and additional data on the Twinalator are contained in Bulletin 552. —K-7

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS



Rapid Reversing Motors

Louis Allis Co. rapid reversing motors are available in a complete line of integral hp, polyphase ratings offered in open drip-proof, totally enclosed, fan-cooled, and nonventilated enclosures. These are also available in blower-cooled constructions that incorporate an integrally mounted blower to supply a continuous unidirectional supply of air for maximum cooling and reversing capacity.

They are primarily designed for high production machine-tool applications, offering up to 125 idle reversals per minute in the smaller sizes with open-type construction and can be built to exceed 200 idle reversals per minute with blower-cooled designs.

The complete line of rapid reversing motors features stator and rotor construction designed to reduce losses and give maximum reversals combined with long motor life.

Other features include Class A insulation with special Class B and H available for special high-reversing-capacity motors; multispeed designs for slow infeed speeds along with faster withdrawal speeds as in the case of drilling and tapping machines, and rolled-shell shaftless designs for compact, direct built-in drives.

For complete information request Bulletin 1800 on "Rapid Reversing" motors.

—K–8

Thrust Bearing

Designed to reduce bearing failures caused by lack of squareness between shaft and housing components, the new cantilever type of bearing, manufactured by Rollway Bearing Co., features an ability to withstand deflection loading.

Bearing plates are finished on one side for applying the load to the roller assembly. The stepped construction requires thicker plates than usual to carry the deflection loading and this thickness is calculated so that the working surfaces of the plates are maintained parallel where the rollers contact. Crowned rollers reduce end stresses between the rollers and thrust plates to provide increased thrust capacity.

Advantages of the new design result in reduced size of shaft forgings and housing castings, lowered tolerances in shaft and housing machine requirements, and improved bearing life.

—K–9

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Vibration Monitors

Indikon Co. has designed two new vibration monitors, Models V/p-2 and V/p-T, to be used in industry for vibration indication and protection. These completely transistorized Indikon monitors, working in conjunction with magnetic vibration pickups, incorporate several distinctive features. The a-c operated Model V/p-2 for general application offers versatility through its wide range of sensitivity. Three full vibration ranges are provided: 0 to 0.1 mil, 0 to 1.0 mil, and 0 to 10 mils. On the most sensitive range, 0 to 100 microin. it is possible to measure vibration amplitudes below 10 microin., and also to detect changes of only 1-2 microin.

Applications for the V/p-2 include protection of compressors, generators, motors, pumps, automatic handling equipment, and production machinery; also the monitoring of high-precision machine operations such as, ruling, grinding, threading, boring, gun-drilling, broaching, and turning.

Model V/p-T designed for pipeline service operates on 48 volts or 60 volts direct current with the a-c line used only to actuate a calibration circuit. A special optional feature available only in the Indikon Model V/p-T provides for the maintenance of continuous vibration protection with an automatic change in the scale factor during the crucial start-up period so that false shutdowns are avoided.

A bulletin containing more detailed information is available on request. **—K-10**

Air Hammer

Heidrich-Nourse Co. developed air hammer useful for riveting, staking, inserting bushings, parts assembling and sheet metal working, repeating hammer will continue 3000-6000 strokes per min as long as contact pressure is maintained with the work. Model 150-RHP-090 is bench mounted.

—K-11

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Rod Ends

Large-size rod ends, control-rod assemblies, and high-angle rod ends with studs are new products now available from Split Ballbearing, Div. of MPB, Inc., manufacturers of "Alinabal" spherical bearings and rod ends.

The bearings are applied in a wide variety of mechanisms, usually in linkage systems where misalignment must be accommodated. Construction features of Alinabal units permit sustained rotational operation, and sometimes the units are applied in crank mechanisms where pounding loads and speeds exceed the capacities of conventional rod ends.

Alinabal bearings are patented, and feature a precision ground, through hardened steel race around an oil-impregnated sintered metal ball. The race is manufactured separately for subsequent assembly around the ball. Loading slots, pressed inserts, or swaged housings are not used in the Alinabal construction method, which permits full utilization of the spherical race enclosing the ball and accurate control of internal clearances.

The new Alinabal products are listed in Catalog 101. **—K-12**

Computer

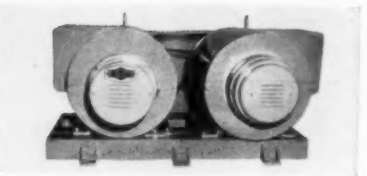
Computing speed, programming ease, operating simplicity are features claimed for the Recomp III computer in production by Autonetics, Div. of North American Aviation, Inc. It is claimed to be the only low-cost computer with floating-point option.

Recomp III consists of only two basic assemblies, the computer module, and the control module. As need for additional functions increases, optional accessories are economically available, including Flexowriter or high-speed tape-punch and tape-reader input/output units, and compacted floating-point hardware.

Specifications and features are given in detail in a recent bulletin. **—K-13**

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS



Motor-Generator Set

Recently developed by Kato Engineering Co. is a high-frequency motor-generator set which produces current at 1200 cps. It was especially designed for electronic testing purposes.

The illustrated machine has a capacity of 20 kw. The alternator rotor has 40 poles, producing 1200 cps at 3600 rpm. The generator is driven by a 40-hp synchronous motor which delivers frequency with clock-like accuracy being driven with a cog-type timing belt.

The alternator is equipped with a d-c exciter which supplies the necessary current to the rotor. The field is controlled by an automatic voltage regulator.

The motor has its own d-c exciter. It is designed to use with a conventional synchronous starter. The field can be controlled so as to produce a leading power factor.

—K-14

Precoated Strip Steel

A new precoated strip steel product that offers fabricators cost and production savings in severe forming operations is being produced by Pittsburgh Steel Co. Thomas Strip Div.

Thomas pre-lubricated strip, newest in the Thomas strip line of specialty strip products, is manufactured with a dual-purpose lubricant coating: produced by treating the steel with a solution combining phosphate and animal fats. Reacting with the carbon steel surface, the solution produces a complex phosphate coating which acts not only as an anchor for a film of fatty lubricant, but also serves to separate the steel from the die or forming tool during the forming process. The fatty lubricant provides high lubricating characteristics. Neither coating interferes with welding.

Although the dual coating can be applied only to plain steel, it can be applied to any type of steel finish.

Subsequent to forming, a hot alkaline bath removes the oily lubricant. A weak acid bath then removes the phosphate coating. However, if the part is to be painted, the phosphate coating provides a good base for paint.

Thomas pre-lubricated strip is available either in coils up to 22 in. wide, or cut lengths up to 24 in.

—K-15

FOR CONSULTING ENGINEERS TURN TO PAGE 178

THE BIG CONDENSING UNITS WITH THE FANDAIRE DESIGN

FANDAIRE AIR-COOLED CONDENSERS

Now Fandaire Condensing Units are available in a full range of sizes from 3 HP through 90 HP – complete with the Fandaire air-cooled condenser and single, dual or multiple compressors.

Units use the original circular design that incorporates exclusive Yuba fintube with its high heat-dissipating efficiency. Every degree of temperature drop is fully used as the circular design approaches true counterflow—where the coolest air is in contact with the coolest gas. Its powerful fan pulls air in from the sides where it is as much as 4° cooler than air from below. Warm used air is pushed up and away. As air is captured from *any* direction, *any* breeze increases the unit's capacity.

The Fandaire Condensing Unit has the highest ratio of capacity to actual size of any condensing unit on the market today.

Installation is easy—no field assembly required. Factory assembly is included in the price. Get full details today on the *big* condensing units with the Fandaire design. Special quotes on custom units.

3-30 HP (single compressor)
10-60 HP (dual compressor)
60-90 HP (multiple compressors)

YUBA

specialists in circular air-cooled condensers and condensing units

YUBA FANDAIRE DIVISION
Tulsa, Oklahoma

YUBA CONSOLIDATED INDUSTRIES, INC.

Circle No. 145 on Readers' Service Card

KEEP INFORMED

BUSINESS NOTES · NEW EQUIPMENT · LATEST CATALOGS

Vibration Control

American Felt Co. has announced the introduction through its national distributors of new Perf-O-Grip Vibra-Mount, a scientifically designed machine undermounting which greatly reduces transmitted vibration and horizontal "creep."

This undermounting combines the cushioning effect of resilient wool felt with a series of perforations spaced at intervals throughout the mounting pads which provide lateral flexibility and help eliminate horizontal "creep" vibration while providing control. Extensive installations prove that Vibra-Mount reduces the destructive force of transmitted vibration by as much as 85 per cent. Vibra-Mount pads are effectively used to reduce vibration characteristic of many types of industrial equipment such as box machines, grinders, boring machines, cylinder presses, looms, business machines, power cutters, shears, punch presses, shapers, vertical presses, pumps, light printing presses, shoe machinery, and so on. **—K–16**

Analog Frequency Meter

In recent years the direct-reading frequency meter has been sidetracked by the digital counter, principally because of the rather low accuracy of the former. The convenience and reliability of the analog frequency meter, however, make it particularly attractive for many types of measurements. Recognizing this, General Radio Co. has developed a new frequency meter, which not only steps up the accuracy by a factor of 10 and greatly increases the range of frequency that can be measured but also doubles as a highly linear discriminator for fm measurements.

The new Type 1142-A frequency meter and discriminator is basically a frequency-to-direct-current converter, operating on the principle of a pulse-count discriminator. Its design features, each tailored to meet definite design objectives, combine to produce an instrument of outstanding performance.

Complete technical details of the instrument and its uses are contained in an article available on request. **—K–17**

Variable-Speed Pulleys

A versatile line of variable-speed pulleys rated at 20 to 25 hp at 1750 rpm, and 10 to 15 hp at 1150 rpm are available from Lovejoy Flexible Coupling Co. They provide instantly variable ratios up to 3 to 1.

Known as Nos. 320 and 325, the pulleys use a No. 27 ($2^{3}/_{4}$-in.) top width variable-speed belt. They can be used with a number of NEMA frames. Standard bores are $1^{1}/_{4}$, $1^{3}/_{8}$, $1^{5}/_{8}$, and $1^{7}/_{8}$ in., with a $3^{3}/_{4}$-in. bore length. Motor travel for full range is $6^{3}/_{4}$ in. The maximum pitch diameter is 13.1 in. and the minimum is 4.35 in. Overall dimensions are $14^{1}/_{4}$ in. long by $13^{5}/_{8}$ in. od. **—K–18**

KEEP INFORMED

BUSINESS NOTES · NEW EQUIPMENT · LATEST CATALOGS

NEMA-Matched Pumps

Under the description of "Adapt-Able" pumps, Fairbanks, Morse has brought out a fast-change unit for application to processing and industrial liquids handling. The feature of this type of pump is that it consists of a pump frame and simple adapter to which can be attached a wide variety of F-M hydraulic ends with enclosed, semi-open, or nonclog impellers—perfectly matched to any NEMA-rated motor and frame. The interesting details of this pump are given in a four-page bulletin now available. **—K–19**

Miniature Indicating Lights

Miniature indicator lights which combine a momentary action push-button switch with transistor circuitry and complete neon indicator in a single unit are features of the new "Tec-Lite" TBL Series "Button-Lite" announced by Transistor Electronics Corp.

The TBL series was designed specifically to solve space and circuitry problems in computers, data-processing, and industrial control systems.

The neon lamp is transistor controlled from small signals which eliminate the need for high voltages in the logic circuits. High voltages and related problems can thus be confined to the panel area. The components are made of black anodized aluminum with matching nut (colors are also available), the body features versatility of mounting. The TBL series is designed to fit $^1/_{16}$ to $^1/_8$-in. and $^9/_{64}$ to $^3/_{16}$-in. panel thickness. Lites mount from the rear with a single knurled nut and lock washer in a $^3/_8$-in. hole on centers as close as $^5/_8$ in. **—K–20**

Packaging Process

A fasten-PAK packaging process which sorts, fills, seals, and prints in one operation also eliminates the chance of error in count with an electronic system. Any type of manufactured metal product which requires fasteners to be packaged can use fasten-PAK, which is made by Mid-Continent Screw Products Co. Products in appliance industries, business machines, metal furniture, vending machines, household hardware, or any other types of equipment requiring packaging of fasteners will benefit from fasten-PAK.

Fasten-PAK will sort assembly materials in a multiple of sizes and assortment. Items may be packaged in either translucent or kraft opaque bags up to $4^1/_2 \times 4^1/_2$ in. It will sort, fill, seal, and print up to three lines of copy on the side of the package in one operation. Fasten-PAK can save you as much as 20 per cent against many hit-or-miss methods. Various types of screws, nuts, bolts, washers, cotter pins, and nails, and many other types of ferrous or nonferrous-metal products can be packaged. **—K–21**

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Special Motor

The Electro Products Div. of Western Gear Corp., announces the design and manufacture of a special motor designed for use in nuclear radiation environment. Identified as Model 36V58RP138, it has an integral gearhead assembly and is applied as a safety rod drive in a nuclear reactor. Its input is 115 volts, 3 phase, 400 cycle. Its output is 20 oz-in. torque at 333 rpm continuous duty. It has an operating life of 1000 hr, is reversible, and is mounted with a precision II gearbox which has a maximum of 1 deg backlash, measured when 150 oz-in. torque is applied. The motor is designed to operate in an atmosphere of water saturated helium gas at an ambient temperature of between 50 and 95 C. It measures $1^1/_2$ in. dia by $2^3/_4$ in. long, not including shaft extension, weighs 14 oz. The manufacturer will supply further information. —K-22

Dehydrators

Johnston & Jenning's Co. Dehydrators are designed so air taken into storage tanks, as product is being pumped out, passes through a desiccant mass that removes moisture, thus preventing dilution and possible contamination of tank contents. They are illustrated and described in a new six-page bulletin. It gives complete information including flow capacities, adsorption rates, dimensions, and installation suggestions. Sizes are 2, 3, 4, 6, 8, 10 and 12 in. They are usually mounted between the roof collar and vacuum relief vent. —K-23

Information Processing System

The Burroughs Corp. B 5000 is a solid-state, medium priced, electronic, general purpose information processing system that establishes new standards of productivity in problem-solving and data processing.

The B 5000, as explained in a booklet recently issued, is proficient for all types of information processing; such as, scientific and engineering problems, as well as commercial and financial data processing. A single user can combine scientific or engineering work with data-processing jobs. —K-24

Welding Helmets

Choice of six welding helmet and two handshield styles is offered in the new Oxweld line introduced by Linde Co., Div. of Union Carbide Corp. Three shell types—straight, curved, and narrow front—are available with either stationary or lift-front glassholders.

All shells are molded in one seamless piece from a glass-fiber-reinforced polyester which is strong and lightweight and has exceptional resistance to sparks, molten metal and flying particles. Headgears are constructed of sturdy plastic and have a simple mechanism for instant, perfect fitting. A "free-floating" suspension system eliminates pressure points for maximum comfort. Plain or hardened filter plates in 12 shades, clear glass and plastic cover plates, and a standard line of replacement parts and accessories are also available. —K-25

Shell Computer Program

One of the most time-consuming tasks faced by many engineers concerns the stress-analysis of elastic shells—such as pressure vessels, bellows, diaphragms, and dewars. This situation has been alleviated by a recent Arthur D. Little, Inc., development; namely, a general shell-computer program that applies to any shell of rotational symmetry. This program reduces the analytical portion of even the most complex problems to a few minutes of computer time.

The ADL shell program, designed for high-speed digital computers, performs a complete stress and deflection analysis for any thin elastic shell of rotationally symmetric form subjected to arbitrary symmetric loading or temperature distribution.

The shell must have the form of a surface of revolution about some central axis, and the loading and temperature profile must be symmetrically disposed with respect to this axis. The shell must be sufficiently thin that conventional elastic thin-shell theory is applicable.

Following an engineering evaluation of the particular shell problem, subprograms describing the geometry, loading, and elastic properties of the shell must be prepared and the desired boundary conditions arranged. Stresses and deflections are printed as output at preselected positions along the shell.

Aside from its obvious application to shell-analysis problems that are a part of more general engineering design or evaluation problems, the new program can easily provide tables of solutions for special shell problems. It can also be modified for computers locally available to a client, whose personnel can be instructed in its operation. —K-26

Graphite Lubricant

"Mexacote" is a quick-drying, nontoxic graphite lubricant that has been developed by the U. S. Graphite Co. Div. of the Wickes Corp., for use on railroad and heavy industrial equipment. The lubricant is compounded from a blend of fine Mexican graphite and special oils. When thinned with turpentine, naphtha, or oleum spirits, the lubricant is easily applied by brush, swab, or spatula. After quickly drying, a tenacious, durable coating having maximum lubricating action is left on the surface.

This lubricant was especially formulated for use on railroad equipment such as switch plates, springs, buffer assemblies, center plates, pedestal jaws, and liners. However, it is also excellent for all types of heavy industrial equipment in various industries where a tough, durable lubricant is essential. It can also be applied to either wood or metal to protect manufactured products. Mexacote is packaged in standard 1-gal paint cans having a net weight of 11 lb. —K-27

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Mud Pump

A new side-suction centrifugal mud pump is offered by Gardner-Denver Co., for supercharging slush pumps and for reduction of pump-power end-shock loading.

The new 4 and 5-in. BN mud pumps allow slush pumps to be operated at maximum pressures and capacities; resulting in longer life of fluid end parts and pistons.

Type 4-in. BN delivers 500 gpm with 25-psi head and 1150 rpm, while the 5-in. BN delivers 750 gpm at the same capacities.

Design features include a high-carbon steel shaft turned, ground, and polished to size. The shaft is chrome plated at packing area for longer life. Deep-groove (grease-lubricated) ball bearings are securely locked to the shaft and held rigidly in the bearing housing. The impeller is carefully balanced with a minimum of machining to protect the hard outer skin, adding longer service life. **—K–28**

Probe-Type Level Control

A fully self-contained capacitance probe-type material level control for direct mounting on bins, hoppers, tanks, or other containers holding dry, semi-dry or liquid materials has been developed by Flo-Tronics, Inc., Electronic Controls Div.

The Flo-Level Model L201 level control is provided in both high-level and low-level units. The probe is integral with the explosion-proof control casing. The entire instrument is mounted as one unit at the point of control desired.

Because of its high-sensitivity range the instrument is particularly useful in connection with such lightweight, low-capacitance materials as plastic powders or pellets. It also has a wide range of level-control applications for powdered or granular materials, semi-liquids, and liquids.

Standard probe length is 6 in. with longer lengths available as required. L201 controls are supplied for either 110 or 220-volt power supply. **—K–29**

Cryogenic Insulation

Oil-Free Spun Banroc Loose, a specially processed mineral wool fiber insulation for cryogenic applications, is described in a product information sheet published by Johns-Manville Corp.

The sheet, IN-311A, lists the forms, uses, and advantages of the material, which has a temperature range from −400 to +1000 F. Advantages included are low oil content, high insulating value, chemical stability, moisture resistance, low density, and ease of installation. In addition, tabular data are given as to physical properties of Oil-Free Spun Banroc Loose, as well as a chart of thermal conductivity at mean temperatures from −100 to +600 F. **—K–30**

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Ball Valves

Flanges which rotate freely around an adapter simplify installation of new McCannaflo flanged-end ball valves. The piping flanges can be installed without regard to the position of the holes. When installing the valve, its flanges are lined up with the pipe flanges, and the bolts are drawn up loosely. The valve can then be rotated a full 360 deg in the line to position the handle at any desired point, following which the bolts are tightened securely.

Manufactured by Hills-McCanna Co. the new valves are furnished in 1/2, 3/4, 1, 1 1/4, 1 1/2, and 2-in. sizes; 150 or 300-lb ASA raised-face cadmium-plated carbon-steel flanges are standard. The valves themselves are available in carbon steel, bronze, and Type 303 or 316 stainless steel. Seats are available in Buna-N or Teflon.

Basic design of the McCannaflo flanged ball valve includes quarter-turn operation, two-way flow, and very low pressure drop. No lubrication is required. The seats are prestressed for driptight closure. Double-back seated stem-seal design is said to eliminate problems of leakage around the stem. **—K-31**

Angle Drives

The F. W. Stewart Corp. announces two new angle drives which offer many advantages not found in previous angle drives which have been designed for a specific purpose.

The 9056HF (T-drive) and 9056-119 (right-angle drive) are provided with 1/4-in.-dia shafts cut to a 1/16-in. flat to provide a stronger attachment for coupling ends. Primarily used with flexible shafting, these new adapters allow for a wider variety of uses than in conjunction with flexible shafting alone.

They are constructed of aluminum alloy housing, steel gears, and utilize oilite bearings. They have an ultimate static torque capacity of 25 lb-in. with a backlash of 6 deg. Furnished in gear ratios of 1:1, 1:2 and 2:1; other ratios are available upon special request. The outlet end of these angle drives may be furnished to rotate either in the same or the opposite direction as the input end. **—K-32**

Template Kits

A complete kit of full-size tracing templates for jig and fixture components are available to tool designers, engineers, and draftsmen without charge from Jergens Tool Specialty Co.

Printed on one side only on individual 8 1/2 × 11-in. sheets of translucent paper, the templates can be used as overlays for correct location of components on drawings and to check fit. They can be slipped under drawings for tracing as either right-hand or left-hand components. The translucent paper also makes it possible to blueprint as many copies of the templates as needed.

Further design time can be saved by tracing only the heavy outline of each drawing and specifying the corresponding part number which automatically gives all detailed parts of complete assembly.

Included in the templates are a number of sizes of cams, knobs, handles, clamps; assemblies, C-washers, fixture jacks, index plungers, strap pads, strap assemblies, flange nut assemblies, knot clamp assemblies, shoe clamp assemblies, and many others. The templates are supplied in a filing envelope with index. **—K-33**

Silicone-Resin Paper

An asbestos-and-silicone resin paper, with no organic binders of any kind, has been added to the Raybestos-Manhattan, Inc., line of Novabestos-base papers. The new material is suitable for operation at Class-C temperatures (over 180 C).

Electrical properties are not impaired by exposure to 275 C for 450 hr. Although temperature limitations are determined by the resin used, the asbestos itself is satisfactory for applications requiring resistance to considerably higher temperatures.

The paper, Style No. 7601S, is available in gages from 0.0025 to 0.0065 in. Based upon a gage of 5.5 mils, the paper weighs 26 lb per 100 sq yd.

The concentration of the silicone-resin impregnation is approximately 60 per cent. The tensile strength of the 5.5-mil paper is 45 lb per in. in the machine direction and 16 lb per in. in the cross-machine direction. The tear strength is 100 grams with the grain and 350 grams across the grain. The average dielectric strength is 450 volts per mil. The heat resistance is 200 C continuous. **—K-34**

Flexible Shaft

The Stow Mfg Co., has recently developed a new stainless-steel, high-temperature flexible shaft. The 6/16-in.-dia core is made up of layers of stainless-steel wire. The outer-flexible interlocked casing and end fittings are also made of 316 and 321 stainless steel. Square fittings on the ends provide the engagement and allow for slight changes in length due to varying torques. Ferrules are made to attach the casing to meet the special requirements of the application. This new shaft is made to the exacting requirements of the aircraft industry and held to close tolerance. Deflection of the flexible shaft in radians/ft-lb can be held to fairly close tolerance also, and the flexible shaft is available in whatever length is required.

This new flexible shaft is well adapted for various high-temperature applications such as operating the fuel control on jet-turbine engines. **—K-35**

KEEP INFORMED

BUSINESS NOTES · NEW EQUIPMENT · LATEST CATALOGS

Seals for Steel Strapping

The Microgrip seal, the first major development in the sealing of steel strapping in more than four decades, has been announced by Signode Steel Strapping Co. The Microgrip represents an entirely new approach to strap sealing. The secret of the new seal's joint strength lies in a special high-friction mastic compound which coats the inside surface in the area within which the crimping action occurs. When the crimps are applied, the mastic compound "bites through" slippery strap coating to provide a strong frictional bond between the metal surfaces.

The new seal combines high joint strength with high impact resistance, and permits the sealing to be done with a minimum of effort. Its use will be confined, for the present, to painted, painted and waxed, or waxed Magnus and heavy duty strapping in $1^1/_4$-in. widths.

Two types of Microgrip seals are now available—the 114G and the 107G. Both are 22 gage. The 114G seal is $2^1/_4$-in. long and may be used with either a B-1435 or UB-1435-50 sealer. The greater length of the 107G—$2^{15}/_{16}$-in.—enables it to be used with the N-1435 pneumatic sealer as well as with the company's two hand-powered models. —K-36

Four-Way Control Valve

A new Rotac-actuated Spherotor four-way directional control valve is announced by Sarasota Precision Products, Inc., a subsidiary of Racine Hydraulics & Machinery, Inc. Spherotor rotary directional control valves feature low pressure drop and a tight seal. These valves are designed for use with oils and noncorrosive fluids or lubricated air, and are available in $^1/_4$, $^3/_8$, or $^1/_2$-in. pipe sizes.

The Spherotor rotary "no leak" valve now can be indexed by a new Midget Rotac manufactured by Ex-Cell-O Corp. Supplying shop air at 100 psi to the Rotac will provide sufficient torque to index the Spherotor four-way valve operating a 2000-psi hydraulic circuit; or a hydraulic pilot circuit so the Rotac can be used. —K-37

Timing Belts

Timing-belt drives for mechanical power transmission are available for load capacities from fractional horsepower up to 600 hp and for belt speeds up to 16,000 fpm. To select a timing-belt drive for any particular application, it is necessary to determine: circular and belt pitch (five stock pitches), drive width, pitch diameters of driver and driven pulleys, and belt pitch length. All the information needed to select the proper timing-belt drive with minimum arithmetic is supplied in the 80 pages of T. B. Wood's Sons Co. new catalog No. 19103. —K-38

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Time and Frequency Meter

General Radio Co. announces an exclusive development in its Type 1130-A digital time and frequency meter. The instrument is designed like a digital computer—to achieve a uniform level of high reliability. Continuous readout is an exclusive feature of the instrument.

The "memory" in the counter constitutes an important new operating aid. Four of the instrument's eight decades are used for storage and continuous display, while the remaining four decades count continuously. At the end of each counting interval, the total accumulated by the counting decades is transferred automatically and quickly (only 100 sec) to the storage and display decades. Continuous counting offers many advantages—information is sampled more often, frequency adjustments become easy, analog recording is greatly simplified, and operator eye fatigue, induced by the dancing lights of intermittent displays, is eliminated. **—K-39**

Filters Valve

A new high-capacity valve design has been developed by Dorr-Oliver Inc. and adopted as a standard component for all their drum and disk filters.

The new valve design offers a completely streamlined flow for filtrate in single and multiple-stage continuous filters. All internal obstructions have been eliminated. In field tests, a filter equipped with the new valve has shown liquid-phase capacity 50 per cent greater than similar filters equipped with conventional valves.

The new valve will be supplied at no increase in price on all single and dual-solution applications of Dorr-Oliver continuous filters including Oliver chemical and metallurgical filters, vacuum-precoat filters, string-discharge filters, and sludge-dewatering filters; and American Savealls and other disk filters. **—K-40**

Split-Eyelet Connectors

In installations requiring fittings for $1^1/_4$, $1^1/_2$ and 2-in. piping or equivalent size tubing, the new Spraying Systems Co. No. 8370 split-eyelet connectors can frequently offer considerable savings in over-all cost. Because they are easily and quickly installed to continuing or un-cut pipe or tube lengths, installation time, and fitting costs are significantly reduced.

These patented split-eyelet connectors (Patent No. 2,946,518) are used in place of reducer tees, and to connect such parts as spray nozzles, gages, and hose nozzles. The split-clamp is made of cadmium-plated, heavy-gage steel or of stainless steel. The bodies provide a $^1/_2$-in. NPT female outlet and are made in choice of brass and stainless steel. Connectors may be used for liquids and gases up to pressures of 150 psi. **—K-41**

Need more engineering information on products featured in this issue?

USE THE POSTAGE-FREE CARDS . . .

If you would enjoy receiving additional engineering information on any of the products

advertised in this issue or

detailed in the Keep Informed Section

. . . . . circle the numbers given on advertisements or items on one of the cards below. . . . . fill in your name and mail to us. Your requests will be promptly forwarded. All information will be directed to you.

(Note: Students please write direct to manufacturer.)

MECHANICAL ENGINEERING—APRIL 1961—Products Advertised

1	15	29	43	57	71	85	99	113	127	141
2	16	30	44	58	72	86	100	114	128	142
3	17	31	45	59	73	87	101	115	129	143
4	18	32	46	60	74	88	102	116	130	144
5	19	33	47	61	75	89	103	117	131	145
6	20	34	48	62	76	90	104	118	132	146
7	21	35	49	63	77	91	105	119	133	147
8	22	36	50	64	78	92	106	120	134	148
9	23	37	51	65	79	93	107	121	135	149
10	24	38	52	66	80	94	108	122	136	150
11	25	39	53	67	81 A,B,C	95	109	123	137	151
12	26	40	54	68	82	96	110	124	138	152
13	27	41	55	69	83	97	111	125	139	153
14	28	42	56	70	84	98	112	126	140	

PLEASE SEND me more complete engineering information on the products advertised in the pages circled above.

NAME .....

TITLE .....

COMPANY .....

ADDRESS .....

CITY and STATE .....

MECHANICAL ENGINEERING—APRIL 1961—Keep Informed Section

K-1	K-11	K-21	K-31	K-41	K-51	K-61	K-71
K-2	K-12	K-22	K-32	K-42	K-52	K-62	K-72
K-3	K-13	K-23	K-33	K-43	K-53	K-63	K-73
K-4	K-14	K-24	K-34	K-44	K-54	K-64	
K-5	K-15	K-25	K-35	K-45	K-55	K-65	
K-6	K-16	K-26	K-36	K-46	K-56	K-66	
K-7	K-17	K-27	K-37	K-47	K-57	K-67	
K-8	K-18	K-28	K-38	K-48	K-58	K-68	
K-9	K-19	K-29	K-39	K-49	K-59	K-69	
K-10	K-20	K-30	K-40	K-50	K-60	K-70	

Code number identifies location of item in Keep Informed Section—beginning page 135

PLEASE SEND me more complete engineering information on the items featured above.

NAME .....

TITLE .....

COMPANY .....

ADDRESS .....

CITY and STATE .....

Need more engineering information on products featured in this issue?

USE THE POSTAGE-FREE CARDS . . .

If you would enjoy receiving additional engineering information on any of the products

advertised in this issue or

detailed in the Keep Informed Section

. . . . . circle the numbers given on these advertisements or items

. . . . . fill in your name and mail to us. Your requests will be promptly forwarded. All information will be directed to you.

(Note: Students please write direct to manufacturer.)

FIRST CLASS
PERMIT No. 1144
NEW YORK, N. Y.

BUSINESS REPLY CARD

NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

MECHANICAL ENGINEERING

29 West 39th Street

New York 18, N.Y.

MAIL THIS CARD

after circling the numbers and filling in your complete address.
NO POSTAGE REQUIRED

FIRST CLASS
PERMIT No. 1144
NEW YORK, N. Y.

BUSINESS REPLY CARD

NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

MECHANICAL ENGINEERING

29 West 39th Street

New York 18, N.Y.

MAIL THIS CARD

after circling the item numbers and filling in your complete address.
NO POSTAGE REQUIRED

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Forged Steel Strainer

Armstrong Machine Works has announced a forged chrome-moly steel strainer, designed for 2500 psi pressure at temperatures to 1050 F. It is suitable for 6000 psi at 100 F. The strainer is available in two sizes and four pipe connections: 26 lb, $^3/_4$ or 1 in., and 56 lb, $1^1/_4$ or $1^1/_2$ in. Socket weld connections are standard including a socket weld blow-down connection. **—K–42**

Automatic Valves

A series of new automatic valves and temperature regulators is being produced by A. W. Cash Valve Mfg. Corp. These include back-pressure relief valves, motorized zone-control valves, industrial high-volume regulators in 2, $2^1/_2$ and 3-in. sizes. These and the full line of relief, reducing, and regulating valves produced by the company are described and tables of particulars are given in Condensed Catalog P&H-60 recently issued. **—K–43**

Adjustable Orifice Valve

A new, easily adiustable orifice valve, the R-105, which permits accurate balancing of steam and hot-water systems, is now available from Marsh Instrument Co., Div. of Colorado Oil and Gas Corp.

A stop screw in the valve stem provides a full range of orifice adjustments without the necessity of shutting down the system or breaking the union connection. Such adjustments are accomplished by a cone which may be set to increase or decrease flow.

The packless R-105 is available in $^1/_2$, $^3/_4$, and 1-in. sizes and in angle, straight, or corner patterns. It can be sealed on the job against tampering. **—K–44**

BUSINESS NOTES

General Kinematics Relocated

General Kinematics Corp. manufacturer of vibratory process equipment, announces the selection of Barrington, Ill., as headquarters. Located at 132 W. Northwest Highway in that Chicago suburb are the general offices and engineering facilities. Marvin Thompson, Vice-President, is in charge of engineering and production.

The company is now introducing its Para-Mount line of vibratory feeders, which are specially designed for new efficiency in handling materials at either a fixed rate or infinitely variable rate in quantities up to 750 tons per hour. Engineered installations suggested by the company include many process systems requiring either single or multiple automatic feed controls such as belt and batch scales, crushers, screens, etc.

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Merger

Flo-Tronics, Inc., has announced the acquisition of its fifth subsidiary in less than six months with the merger of Electric Service Systems. The agreement was based on an exchange of stock. Electric Service Systems will operate as a completely separate subsidiary. Other recent Flo-Tronics mergers include Rubber Industries, Inc., Wilcox Products Co., Plasticos, and Atkinson Bulk Transport Co. Each is an independently operating subsidiary.

LATEST CATALOGS

Cooling Towers

Reinforced-concrete, natural-draft cooling towers form the subject of a comprehensive brochure prepared by Hamon Inc., based on half a century of experience in this field in many countries. The publication traces the evolution of the modern cooling tower, its technical and practical aspects of design and construction, and illustrates many successful installations. —K-45

Chemical-Process Pumps

In Circular No. 217, Dean Brothers Pumps Inc. features Type "pH" chemical process centrifugal pumps for corrosive and non-corrosive liquids and slurries. Type "pH" series pumps are horizontal, single-stage, end-suction, vertically split-case, full-open impeller, base-mounted, centrifugal pumps with shaft extended for direct connection through the spacer-type flexible coupling to motor, turbine, or engine driver. Fourteen sizes are available in the range from 5 to 5000 gpm at heads from 20 to 260 ft of liquid. —K-46

Ductile-Iron Valves

Ductile-iron regulators and control valves are treated in a four-page Bulletin J-DI now available from OPW-Jordan Corp. The bulletin is also a condensed catalog of all OPW-Jordan products. In addition, it fully illustrates and describes the sliding-gate seats available in all OPW-Jordan regulators and control valves. The bulletin describes in detail the composition, properties and specifications of ductile-iron valves and has a comparison table on steel, cast iron, and red brass versus ductile iron, plus, the results of a severe quench test on ductile iron. It explains how ductile iron is able to replace steel in many applications at a considerable saving in cost. —K-47

Maintenance Assist

A 16-page illustration booklet, Bulletin No. 24, presenting helpful facts about making maintenance and repair parts has been made available by La Salle Steel Co. The booklet, entitled "One Way to Make Your Job a Little Easier," will be of particular interest to maintenance executives, engineers, and other key maintenance personnel. The publication offers solutions for those persons faced with the problem of getting machinery repaired and back into production fast . . . and at minimum cost. It will also prove helpful to designers, production and research men who must make any kind of special machinery or equipment requiring machine parts. It offers ideas on how to save time in machining parts, eliminate heat-treating, quench cracks and last minute parts rejections. It also suggests ways to avoid secondary operations such as cleaning, straightening, finish grinding, and inspections . . . which will help get equipment back into operation in hours rather than days.

Included in the booklet are physical properties, chemistry and tolerances for "Stressproof" steel bars, widely used in both production and maintenance and parts applications. —K-48

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Rotary Joints

Rotary joints that require no lubrication, work equally well for single-flow or syphon steam service, and handle steam and virtually any fluid ranging from chilled water to 600F oil, are illustrated and fully described in Catalog 310B which has been released by Barco Co.

Barco's design for a rotary joint take full advantage of newest corrosion-resistant materials in combination with inert low-friction seals and bearings to provide near indestructible joints in eight standard threaded end sizes from 1/2 through 3 in. The basic design is also incorporated in flanged connection joints in the larger sizes, in special rotary syphon joints, and in new heavy-duty shock load-resistant rotary joints. —K–49

D-C Receivers

A revised two-page, illustrated products specification sheet, E12-4, which describes various classes of Bailey d-c receivers is available from Bailey Meter Co.

D-C receivers pick up signals from transducers such as thermocouples, tachometers, and pH electrodes and convert them to pneumatic or electric signals to drive a recorder pen.

Bailey d-c receivers are adapted to applications by power plants and process plants such as nonferrous metal, pulp manufacturers, and aircraft-engine manufacturers. Performance characteristics of Class E and F receivers are listed in the product specification sheet and include range, accuracy, sensitivity, response, and power supply. Also included are schematic diagrams and detailed specifications for the d-c receivers. —K–50

Welding Equipment

A new short-form catalog describing the thin-metal welding equipment line of Hughes Aircraft Co. vacuum tube products division is now available.

The catalog illustrates nine different power supplies and eight different weld heads and handpieces. The power supplies range from a 5 kva, half-cycle, a-c unit through a 500 watt-sec stored-energy unit. Specifications are shown for all units. They feature an extremely short discharge time, metered controls on the stored-energy models, and standard production bench sizes for easy installation.

Welding heads and handpieces, designed for a variety of applications ranging from medium-duty to extremely fine precision spot welding, are illustrated. All weld heads feature low inertia to allow for quick follow-through on welds. The catalog also describes the company's free weld evaluation service. Weld feasibility studies, first level testing, and metallurgical analysis are part of the services offered. —K–51

Industrial Furnaces

A wide variety of installations of Sunbeam Equipment Corp. industrial furnaces is illustrated in a folder of recent issue. Furnaces are available in many types, gas-fired, electric, and oil. A chart of heat-processing applications lists the most suitable type furnace for each. —K–52

Air-Vent Silencers

The Metal Products Div. of Koppers Co., has published a brochure on the sizes and guaranteed performance of Aircoustat return air vent silencers. The brochure points out that the silencer is designed to prevent the transmission of noise from one area to another through transfer grilles.

The sound trap permits the passage of air while, at the same time, impeding the flow of annoying sound between rooms. According to Koppers, it can be installed in a wall or a ceiling or hung on a wall or door. —K–53

Controls

Pressure, flow and liquid-level controls produced by McAlear Mfg. Co. are described in a condensed bulletin. Essential information is given for only a part of the McAlear line applying to equipment for the control and regulation of steam, water, air, oil, and gas. Such items as diaphragm motor valves, liquid-level controllers, pressure-reducing valves, pump governors, back-pressure valves, and so on are treated. —K–54

Water Treatment

An indexed manual entitled "Custom Water Treatments" is now available from Vulcan Laboratories, one of the Associated Laboratories, Inc., group of water-treatment specialists.

This manual contains a series of specifications for boilers, cooling, and domestic water treatments, with details of testing equipments and their applications. —K–55

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Ventilating Fans

Fans for ventilating and industrial purposes are described briefly in an illustrated four-page bulletin issued by the Barry Blower Co. —K-56

Regulating Valves

Bulletin No. 500 distributed by Hubbell Corp. gives brief particulars of controls for refrigeration, air-conditioning, and industrial applications. Include solenoid valves, pressure-regulating valves, safety valves, suction stop valves, and other types. —K-57

Mercury Relay

A new design in plunger-type relays has been developed by The Mercoid Corp. Features are described in Bulletin 0-20. These relays are suitable for heavy-duty loads such as resistance heating (domestic, commercial, industrial), heat-treating furnaces, drying equipment, welding, illuminated signs, and score boards, and so on. —K-58

Centrifugal Pumps

Bulletin 107 of Chicago Pump Co. presents complete selection charts and drawings of its flexible-coupled centrifugal pump available in capacities of 5–900 gpm and pressures of 10–275 ft total dynamic head. A description is given of mechanical details, particular mention being made of the Chicago Ceramic Mechanical Seal. A list of suggested F-C pump applications is included. —K-59

Silicon and Selenium Rectifiers

An illustrated catalog describing its complete line of certified silicon and selenium rectifiers has been published by the Semiconductor Div. of Syntron Co.

Illustrated in color, the eight-page Condensed Catalog No. 100 is featured by cutaway drawings revealing the construction features of Syntron's silicon diodes and stacks, and its selenium rectifiers, stacks, and cartridge rectifiers.

A full list of more than 350 JEDEC types of silicon rectifiers which are available from Syntron is included.

Complete electrical and mechanical specifications are listed in individual tables devoted to each product line. Typical operating characteristics of both silicon and selenium rectifiers also are shown in curves displaying forward current rating levels and derating curves for raised ambient temperatures. —K-60

Gas Turbine

New Model 305-S single-shaft gas turbine for mechanical and generator drive is presented in Bulletin 186, released by Clark Bros. Co., one of the Dresser Industries. Important advantages such as simplicity, reliability, compactness, and low first cost of this 9000-hp unit are fully discussed.

All important design features such as multistage axial compressor, three-stage turbine, air cooling of turbine disks and blade roots, unitized contraflow combustion chamber, horizontally split casing, bearings external to hot gases, and fabricated steel base plate with integral lube-oil reservoir are highlighted. —K-61

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Network Simulator

A new active-passive network simulator for transient field problem is the title of an eight-page article by Doctor Walter J. Karplus. The article discusses the new system in which a wide variety of problems characterized by partial differential equation simulated by means of a network consisting only of positive and negative resistors. Copy available from George A. Philbrick Researchers Inc. —K62

Components for Computers

The Burroughs Corp. recently published an illustrated catalog telling the story of the research, engineering, automated design, manufacturing, quality control, automatic programming, and customer services that are necessary to transform components into computation in the office.

It shows how Burroughs Corp. has combined its experience and capabilities in commercial electronic data processing with advanced techniques developed in its military computer programs to produce new commercial information-processing systems designed to meet the specifications demanded by experienced computer users at prices that provide new highs in productivity per dollar. —K-63

Compensating Regulators

Electric or air-operated back-pressure compensating valves are described and applications noted in a 16-page bulletin now available from the Hubbell Corp.

These regulators are designed to provide positive, automatic regulation of suction pressures in a refrigerating system, eliminating adjustments performed manually which normally would be required to maintain constant conditions and varying system load. —K-64

Well Drilling

Bulletin No. 10, Layne General Services Bulletin, a new four-page, three-color brochure issued by Layne & Bowler, Inc., giving general facts and information on water well systems, water pumps, well drilling and allied water services and equipment for municipalities, industry, and agriculture.

Additional bulletins are listed for detailed information on well drilling, well casing and screen, pumps, chemical treatment of water wells and water treatment —K-65

Double Suction Pumps

Type DS and DP, double-suction, single-stage, horizontally split-case centrifugal pumps produced by the Chicago Pump Co. are described in Bulletin 102. These pumps are particularly suited for building services, such as air conditioning, heating, pneumatic water systems, refrigeration, booster service, snow melting, and so on. Typical installations are illustrated and mechanical details and features are noted. —K-66

Optical Maser

A booklet describing the theory and design of the recently announced solid state optical maser is now available from Bell Telephone Laboratories, Inc.

An optical maser is a device which produces a narrow beam of coherent light. In coherent light, all the waves possess a definite phase relationship to each other. It is this property in radio waves which makes it possible to modulate, direct, and control them, and to use them in communications. Because of the tremendously higher frequencies of light, vastly increased amounts of information could be carried on a coherent light beam, when technology is further advanced. The eight-page booklet, bears a full-color cover picture of an operating maser emitting a pulse of coherent light.

There are a number of other applications which will be of interest also. The activation of specific chemical reactions in the presence of competing compounds, application of tremendous amounts of energy to extremely small areas, and improved standards of length are among the possibilities. —K-67

KEEP INFORMED

NEW EQUIPMENT BUSINESS NOTES LATEST CATALOGS

Transmission Linkage

A folder describing "Modern Chain for Modern Power" has been issued by Morse Chain Co., a Borg Warner Industry. The basic gear-like action of Hy-Vo results in high rpm performance of gears combined with the versatility, economy, and lower peripheral speed of chain. Hy-Vo is stocked in pitches from 3/4 to 2 in. and is available in widths from 2 to 24 in. The folder gives an outline of many advantages claimed for Hy-Vo and a table of comparison with gear drive.—K–68

Centrifugal Pumps

A complete selection of single-stage centrifugal pumps for industrial, chemical, petroleum, process, and refining services is presented in Circular No. 184, being distributed by Dean Brothers Pumps Inc. In addition to specification details of numerous types of pumps available, head-capacity charts are given for each. These pumps are for service from −350 to +1000 F, at working pressures to 1000 psig. —K–69

Pressure Controls

A data sheet on Series AP Mercoid instrument air pressure controls is being distributed by The Mercoid Corp. Features of these controls include external adjustment, sealed mercury contact, visible switch position; available for panel of pipe monitoring. —K–70

Induced-Draft Cooling Towers

A new booklet issued by Hamon, Inc. covers induced-draft, counterflow-type cooling towers for industrial applications such as chemicals, petroleum refining, electric power, processing plants, and so on. These towers are particularly suited for conditions where low approaches are necessary or where piecemeal expansion is contemplated. Cooling towers discussed in this brochure have capacities above 2000/3000 gpm per cell, the minimum size depending upon imposed temperature conditions. Generally built of reinforced concrete with an asbestos-cement packing, they are erected with local materials, manpower, and equipment. —K–71

Conditioning and Heating Equipment

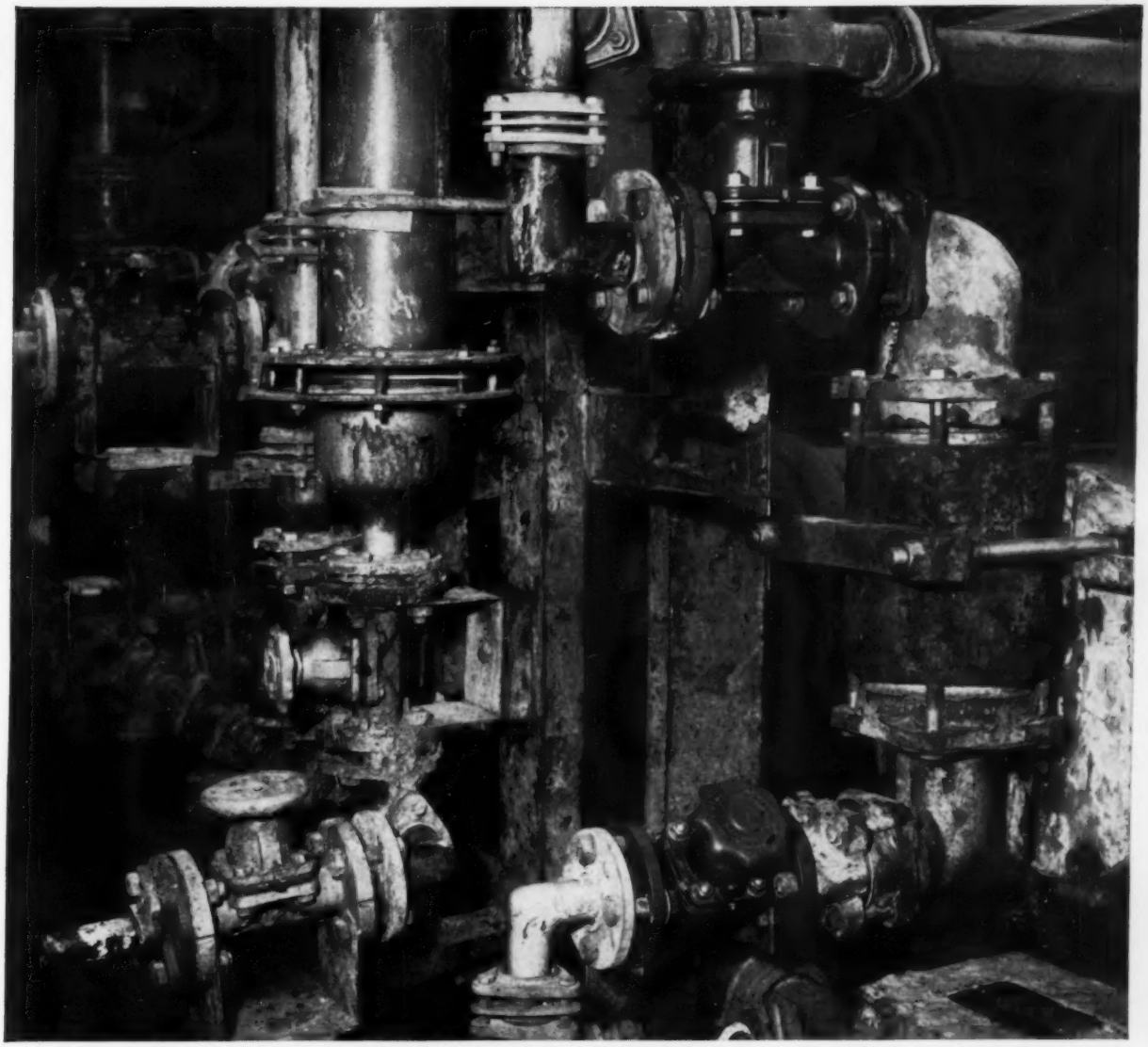
A four-page bulletin giving in condensed form the line up of products for air conditioning, heating, and industrial heat-transfer equipment of the Marlo Coil Co. is available. Brief descriptions are given of each of the many types illustrated. —K–72

Adjustable-Speed Drives

Bulletin 2900 of the Louis Allis Co. describes four types of adjustable-speed drives in the range from 3/4 to 2000 hp.

The Ajusto-Spede provides stepless, accurately controlled adjustable speed in 1 to 5-hp integrally constructed motors, and 7 1/2 to 100 hp in flange-mounted units. Magnetic drive is available in ratings of 50 to 2000 hp. Select-a-Spede with Flexitorq d-c drive motor is available in ratings from 5 to 400 hp. Allispede is an a-c motor-driven, mechanical adjustable-speed drive with speed from 1 to 10,000 rpm in the range of 1 to 25 hp.

All units have special designed controls. —K–73



Encrustation on two of the above valves was cleaned off to show lack of external corrosion. Compare this with the corroded condition of the structural steel.

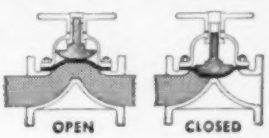
Grinnell-Saunders Diaphragm Valves resist attack by hot corrosives at Carborundum Metals Company

During the past few years, Carborundum Metals Company, a Division of the Carborundum Company, has installed over 200 Grinnell-Saunders Diaphragm Valves at their Parkersburg plant in West Virginia. These valves were coated internally and externally with Penton * —and were equipped with fluorinated plastic diaphragms, backed with elastomer cushions. Their job: to handle highly corrosive caustic soda and sodium hypochlorite–at 212°F, and methyl isobutyl ketone, hydrochloric acid, sulphuric acid at 130°F–all used in processing zirconium ore for zirconium and its co-product, Hafnium.

Today, this manufacturer reports that after being in operation an average of two years, the rugged Grinnell-Saunders Diaphragm Valves are still giving good service. What's more, they've never had to replace parts in these Grinnell Valves!

In Grinnell-Saunders Valves, the diaphragm lifts high for streamline flow – seals *tight* for positive closure. Working mechanism is completely isolated from material in the line to prevent corrosion and contamination. There's a wide choice of body, lining and diaphragm materials, too. See how Grinnell-Saunders Diaphragm Valves can help *your* installation.

Write Grinnell Company, Providence 1, Rhode Island.



* *Reg. T.M., Hercules Powder Co.*

GRINNELL

GRINNELL COMPANY, PROVIDENCE 1, R. I. • BRANCH WAREHOUSES AND DISTRIBUTORS FROM COAST TO COAST
PIPE FITTINGS • VALVES • PIPE HANGERS • PREFABRICATED PIPING • UNIT HEATERS • PIPING SPECIALTIES

Circle No. 66 on Readers' Service Card

No one trap can do *everything* better than every other trap. Some traps vent air better than others, some remove condensate faster, etc. But, there is no one trap *best* in every phase of trapping. Armstrong has been manufacturing the Inverted Bucket Trap for nearly fifty years, and though the traps have changed with the requirements of the times, the Inverted Bucket principle has remained. For on overall trap performance, year-in and year-out, nothing beats the Armstrong Inverted Bucket Trap. It's a rugged well-built trap that does *more* things better than any other trap. It's guaranteed because it's been proved.

For more details, see your Armstrong Representative and start living . . .

P. S. Like some good meaty reading? Ask for the 48-page Armstrong Steam Trap Book.

ARMSTRONG MACHINE WORKS
8948 MAPLE STREET
THREE RIVERS, MICHIGAN

"See our Catalog in Sweets' Plant Engineering Catalog"

011-ST

Circle No. 12 on Readers' Service Card

DIMENSIONS—TOLERANCE—TERMINOLOGY

For Small Tools and Machine Tool Elements

Established by Authorities Approved as American Standards Used by Industry

ACCURACY OF ENGINE AND TOOL ROOM LATHES, B5.16—1959. $1.00
Gives the tolerances to which industry is building 12 in. to 18 in., 20 in. to 32 in., and 40 in. to 72 in. lathes and the tests for determining the accuracy of the lathes.

CHUCKS AND CHUCK JAWS, B5.8—1954 (Reaffirmed 1959). $1.50
Establishes controlling dimensions for all chucks from 6-in. to 36-in. diameter of both medium and heavy duty types, for an extra heavy series of chucks with serrated master jaws, for power-operated and hand-operated chucks of two-, three-, and four-jaw types

CIRCULAR AND DOVETAILED FORMING TOOL BLANKS, B5.7—1954. $1.50
In this standard are the sizes and types of tool blanks and the associated mounting portions of their respective holders for use on 60 types of automatic screw machines, the latter being classified in the standard into six different groups of comparable stock capacities. Tolerances and screw threads are specified.

CARBIDE BLANKS AND CUTTING TOOLS, B5.36—1957. $2.00
Gives the sizes, styles, designations, dimensions and tolerances of eight styles of sintered carbide blanks; tipped tools with square or rectangular shanks; boring tools and tool bits; and inserts $1\frac{1}{8}$" long and their holders.

DESIGNATION AND WORKING RANGES OF GRINDING MACHINES, B5.32 and 33—1953. $1.00
Data and information supplied by this standard apply to all sizes of reciprocating table surface grinders having horizontal spindles and to all swings of plain cylindrical grinding machines up to and including 36 in. size.

DRILL DRIVERS (Split-Sleeve, Collet-Type), B5.27—1959. $1.50
This standard gives taper dimensions, general specifications, and the dimensions for 151 sizes of drill drivers along with the standard and optional taper number of each size.

DRIVING AND SPINDLE ENDS FOR PORTABLE AIR AND ELECTRIC TOOLS, B5.38—1958. $1.50
These dimensions and tolerances are for both driving and driven elements of portable powered tools of either air or electric type. Sizes are listed both by drill size and by the decimal equivalent. Also covered are threaded spindles for geared chucks and abrasion tools, Jacobs tapers, and hexagonal and square drives.

HIGH SPEED STEEL AND CAST NONFERROUS SINGLE POINT TOOLS AND TOOL HOLDERS, B5.29—1959. $1.00
The tools for which sizes and tolerances are given in this standard are those in common usage for general purpose machine. Additionally the standard gives the nominal shank sizes of tool bit holders.

INVOLUTE SPLINES, SERRATIONS, AND INSPECTION, B5.15—1960. $5.00
In this new standard data are presented in a form that pin-points application rather than tooling problems. Specifically it provides guidance and data for the design of straight (non-helical), involute spline teeth and involute serration teeth, presents dimensions for splines and serrations of recommended pitches, also a methodical treatment of manufacturing errors and their effect on the fit between mating parts. Spline tooth dimensions cover a range from 2.5/5 to 48/96 pitch and from 6 to 60 teeth, while the serration tooth dimensions cover the full range from 6 to 100 teeth for 10/20, 16/32, and 24/48 pitches, and a more limited range of teeth in the 32/64, 40/80, 48/96, 64/128, 80/160, and 128/256 pitches. Inspection methods; types of gages used, also their function and selection, gage dimensions and tolerances, gage blanks, measurement with pins; measurement of spline and serration errors are dealt with in considerable detail.

INSERTED BLADE MILLING CUTTER BODIES B5.23—1958. $1.50
In this standard are the dimensions and dimensional tolerances of cutter bodies for shell end mills, half side mills, staggered-tooth side mills, face mills—flat back series, and face mills—series 50 in a diameter range of 3 to 24 in.

JIG BUSHINGS, B5.6—1941 (Reaffirmed 1949). $1.00
Dimensions for: Press-Fit Wearing, Renewable-Wearing and Liner Bushings.

KNURLING, B5.30—1958. $1.50
This standard specifies dimensional relationship between the knurling tool and stock and gives standard diametrical pitches for tools.

LIFE TESTS OF SINGLE-POINT TOOLS, B5.19—1946 (Reaffirmed 1953). $1.00
Shows how to evaluate performance of single-point tools made of material other than sintered carbides.

LIFE TESTS FOR SINGLE-POINT TOOLS OF SINTERED CARBIDE, B.34—1956. $1.00
This test procedure for determining tool life covers grade, shape and size of tool, material to be machined, the shape and size of cut, the cutting fluid, and relationship between tool wear and cutting time.

MACHINE MOUNTING SPECIFICATIONS FOR ABRASIVE DISCS AND PLATE MOUNTED WHEELS, B.35—1957. $1.50
Establishes standards for location and size of bolt holes in steel disc wheels (machine face plates) and the mounting side of abrasive discs and plate mounted wheels. Twenty-seven illustrations supplement the text.

MACHINE PINS, B5.20—1958. $1.50
These dimensions are for hardened and ground dowel pins, straight pins, ground dowel pins (not hardened), taper pins, clevis pins, and cotter pins. An appendix gives drilling specifications for taper pins and a drill chart for the size of drill and number required.

MACHINE TAPERS, B5.10—1960. $2.50
This standard establishes standard practice for the slope of self-holding and steep machine tapers, provides detailed dimension for this type of taper tool shank, and gives the corresponding dimensions for the taper socket in the spindle of the machine, including the dimensions of keyways. An appendix tabulates Brown and Sharpe tapers, and additional Morse tapers not included in the standard, also Morse stub tapers and Jarno taper data.

MARKINGS FOR GRINDING WHEELS, B5.17—1958. $1.00
Covering markings only, this standard establishes a symbol for each of the most essential characteristics of a grinding wheel and arranges them in uniform sequence.

MOUNTING DIMENSIONS OF LUBRICATING AND COOLANT PUMPS FOR MACHINE TOOLS, B5.28—1958. $1.00
Tables give specific mounting dimensions for motor-driven centrifugal pumps, centrifugal and geared pumps, centrifugal pumps (flange mounted type), gear and vane pumps and for mounting brackets.

MILLING CUTTERS, B5.3—1960. $3.00
Covering milling cutters of one piece construction, this standard describes, illustrates, and gives the principal dimensions of 24 types of profile sharpening milling cutters, five types of form relieved milling cutters, milling cutter tolerances, dimensions of keys and keyways for milling cutters and arbor, and dimensions and tolerances for weldon shanks.

PUNCH AND DIE SETS FOR TWO-POST PUNCH PRESS TOOLS, B5.25—1950. $1.50
These dimensions for back-post and diagonal-post sets cover die area, the die holder and punch holder thickness, shank diameter and lengths, guideposts and bushings, and removable punch holder shanks.

REAMERS, B5.14—1959. $2.50
Following a comprehensive glossary of reamer terms, tolerances and general dimensions are given for thirty-seven types of reamers including an extended series of high speed steel straight shank reamers.

ROTATING AIR CYLINDERS AND ADAPTERS B5.5—1959. $1.00
Here are given the dimensions of ten sizes of air cylinders, the pull and stress data at 100 lb. square inch air pressure, the dimensions of four sizes of adapters, and the sizes of adapter screws and tapped holes.

SINGLE POINT TOOLS AND TOOL POSTS B5.22—1950. $1.50
Illustrates and defines classes of tools, their parts and angles at which they are used; gives dimensions of tool shank, tool post openings, and tool holders.

SPINDLE NOSES AND ADJUSTABLE ADAPTERS FOR MULTIPLE SPINDLE DRILLING HEADS B5.11—1954. $1.00
Here are the general dimensions of spindle noses and multiple head assembly; the detail dimensions of adjustable adapter body, set screw slot, adjustable extension adapters, and adjustable adapter set screw and friction lock nuts. Tolerances, finish and marking are specified.

SPINDLE NOSES AND ARBORS FOR MILLING MACHINES, B5.18—1960. $1.00
Contains dimensions of the spindle noses, ends of arbors and adapters, and draw-in bolt ends.
An important new addition to this 1960 document is the table of dimensions of the spindle nose with large flange. Revisions incorporated affect certain of the essential dimensions given in the 1958 standard.

SPINDLE NOSES (For Tool Room Lathes, Engine Lathes, Turret Lathes, and Automatic Lathes), B5.9—1960. $2.50
Includes dimensions for each type and size of spindle nose, also the dimensions of gages, face plates, and fixtures.

STRAIGHT CUT-OFF BLADES FOR LATHES AND SCREW MACHINES, B5.21—1949. $1.00
Gives dimensions of the height, length, and thickness of the approved four types of blades, and includes sketches to show the optional shapes for cut-off blade stock.

T-SLOTS, THEIR BOLTS, NUTS, TONGUES, AND CUTTERS, B5.1—1949. $1.50
Tables show dimensions of T-slot, their tongues and cutters, and of inserted and reversible tongues and tongue seats. Tolerances are specified.

TAPS—CUT AND GROUND THREADS, B5.4—1959. $2.50
It describes the various tap styles, includes nomenclature and definitions, and presents complete specifications of the standard taps, including styles such as oversize machine screw taps, helical flute taps, and spiral point taps with short flutes. It also lists the tap recommendations for all classes of Unified screw threads.

TWIST DRILLS, B5.12—1958. $2.00
Included in this standard are nomenclature, definitions, sizes and tolerances of two flute straight and tapered shank twist drills, combined drills and countersinks, selected sizes of millimeter drills, screw machine length drills, jobbers length and taper length drills. Drill sizes and their decimal equivalents are also listed.

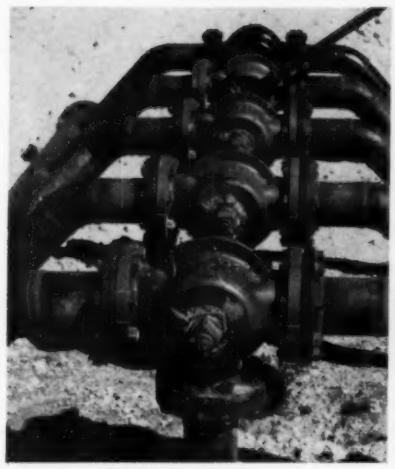
BINDERS

A specially designed binder for holding these standards is available. It is 9" × 12" in size and provided with flexible steel rods which can be slipped out of or under the top and bottom metal lips. It gives every advantage of a bound book together with the added convenience which comes from the ability to instantly insert, remove or transpose sections of the contents. **Price, $3.25**

20% Discount to ASME Members. Save mailing and handling charges by remitting with order

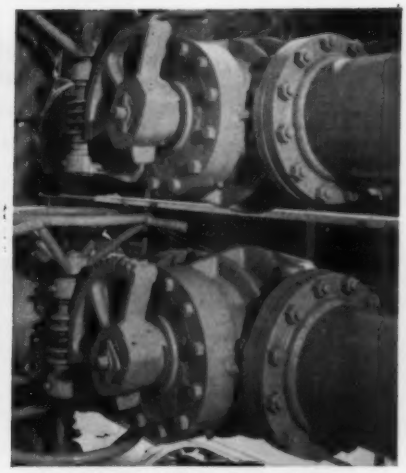
Published by

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, 29 W. 39th ST., NEW YORK 18, N. Y.



Oilfield Service

Uranium Processing

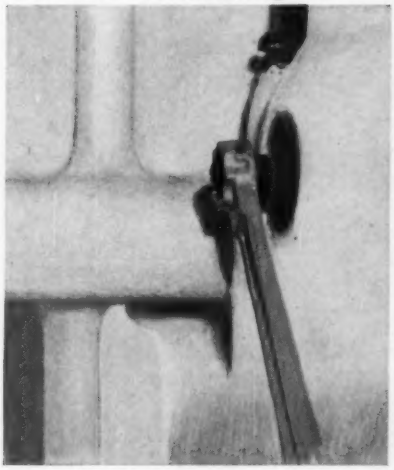


Cement Manufacturing

When so much depends on a valve...

Chemical Processing

Air Conditioning



Sewage Service

Specify the non-wedging cylindrical plug: W-K-M's ACF® Lubricated Plug Valve

This unique valve meets critical dependability requirements because the plug is *cylindrical*. It *can't wedge* . . . can only *rotate*, like a journal in a well-lubricated bearing. Result? Smooth quarter-turn operation that makes the ACF plug the workhorse of industry. It handles gases, liquids and abrasive slurries — all with outstanding dependability and economy. And port-size for port-size, ACF Lubricated Plug Valves are competitive in price. Find out more . . .

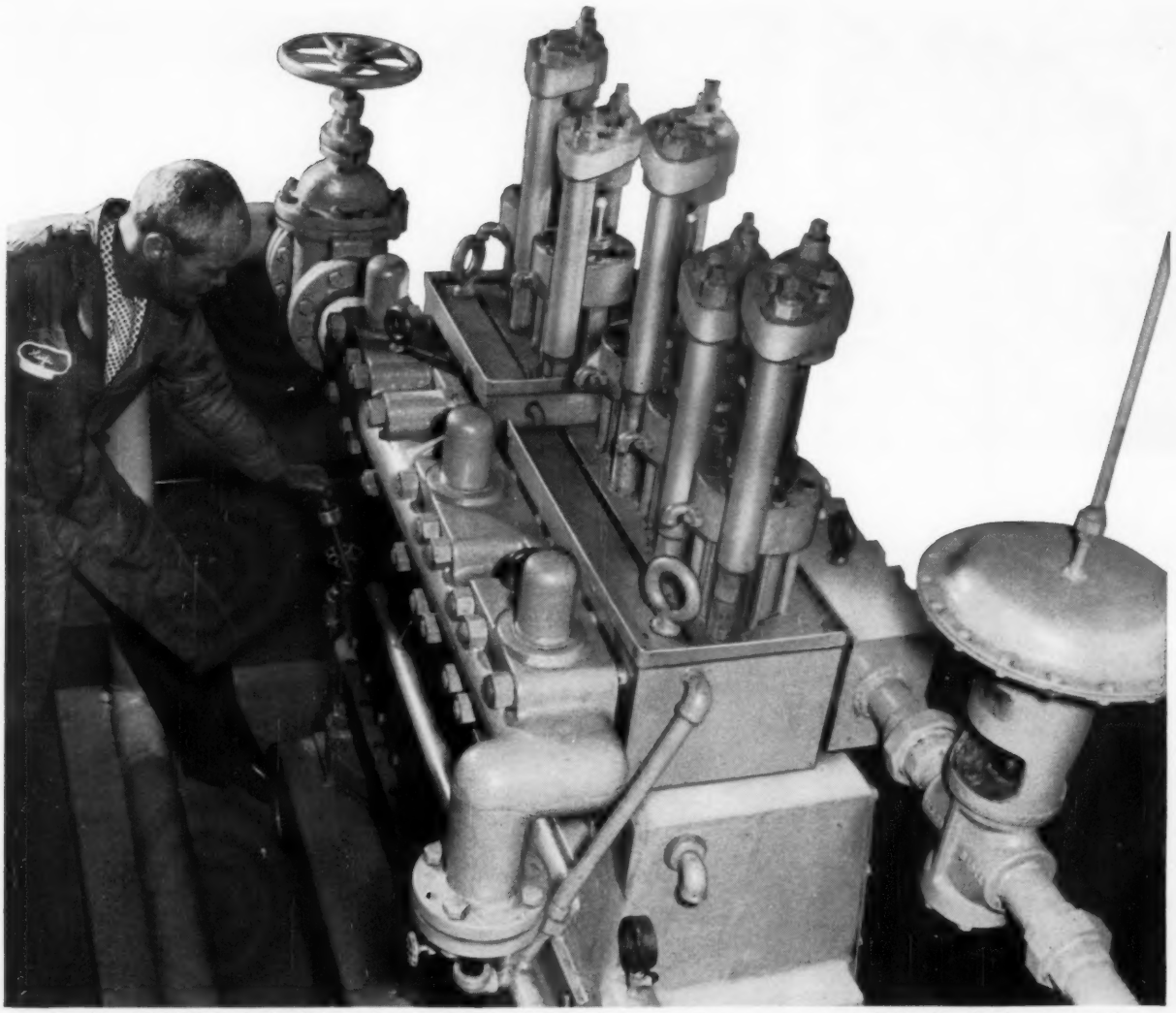
WRITE FOR CATALOG 400

ACF LUBRICATED PLUG VALVES are available in round, rectangular, diamond and V-ports; also in venturi, multi-port and steam-jacketed models. Sizes: ½" through 30"; Working Pressures 125 through 800 lbs.

W-K-M

DIVISION OF ACF INDUSTRIES
INCORPORATED
P. O. BOX 2117, HOUSTON, TEXAS

6010



One of two Aldrich Pumps on 3-shift duty; they are quintuplex (shown) and triplex models operating at Schacht Rubber Mfg. Co., Huntington, Ind.

No easy life for this Aldrich pump

Here is an Aldrich Pump that gets no rest at all. Rubber molding and extrusion presses demand its service 24 hours a day. Pressure requirements are just as exacting . . . 170 gpm at 1200 psi must be maintained accurately, steadily. Quality of product and total productivity depend upon it. Rejects have been held to a minimum, tight delivery schedules have been met.

At the Schacht Rubber Mfg. Co., Aldrich pumps deliver water with soluble oil to presses turning out rubber houseware and hardware goods. No downtime has ever resulted. Maintenance? Routine . . . every six months. An oil check and an occasional packing replacement is all that has been required.

Get in touch with Aldrich Pump Co., 29 Pine St., Allentown, Pa. for any pump 5 to 2500 hp, up to 50,000 psi, specials to 100,000 psi. Aldrich has a pump just as tough as you need because . . .

THE TOUGH PUMPING PROBLEMS GO TO ALDRICH

Circle No. 5 on Readers' Service Card

Diamond developed for more economical power

MONITORMATIC...NEW SELF-CONTROL FOR MORE EFFICIENT BOILER CLEANING

Optimum frequency of blower cycling is assured with Monitormatic . . . Diamond's completely automatic boiler cleaning system.

Monitormatic is an automatic method of maintaining constant furnace cleanliness and heat absorption. It responds automatically to changing boiler conditions and eliminates indiscriminate, unnecessary or insufficient blowing. Savings are realized through optimum use of blowing medium, minimized soot blower maintenance, less compressor maintenance if air is used as blowing medium, and reduced operator time. It also automatically adjusts the cleaning system to fuel changes.

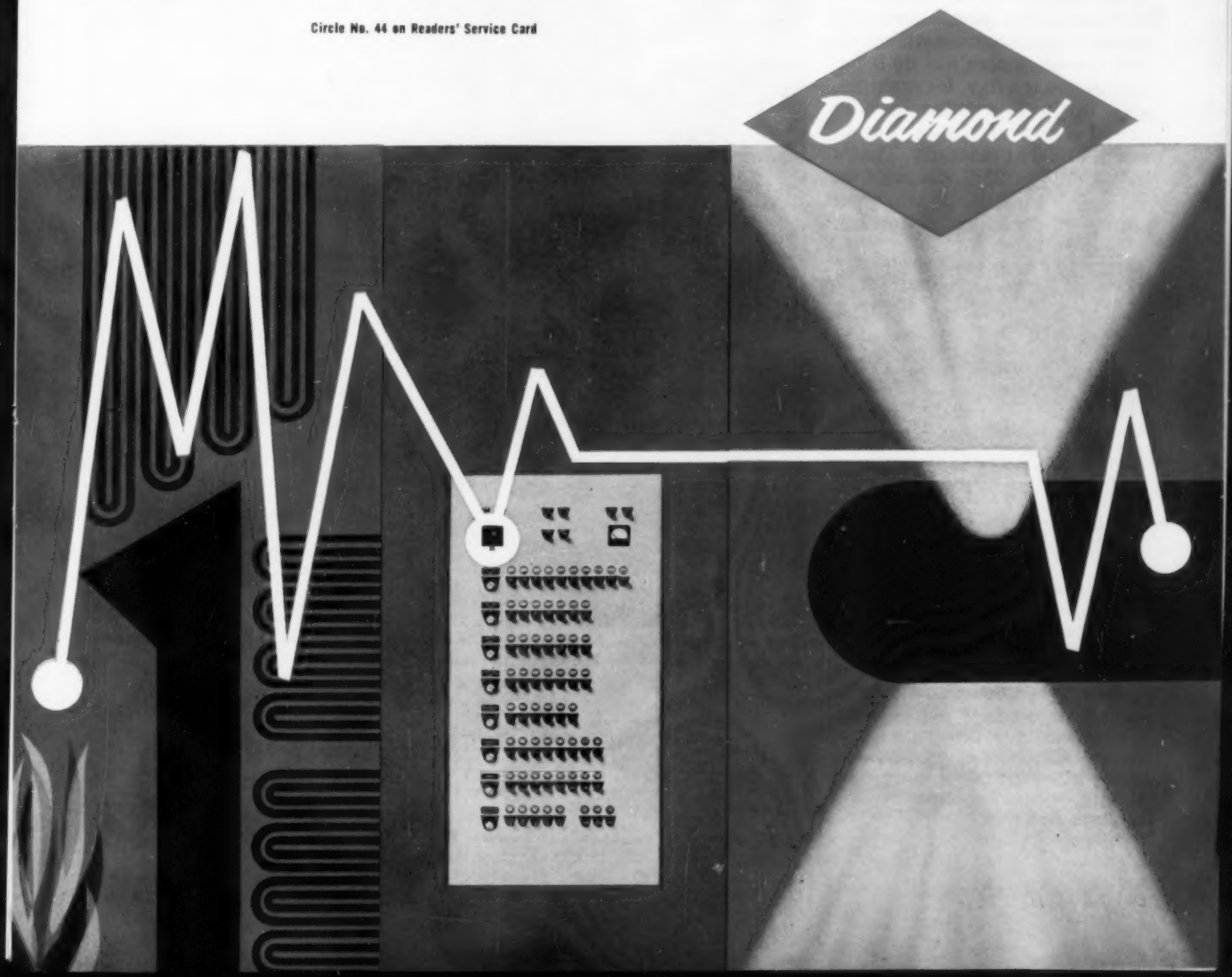
Monitormatic is readily and economically applicable to new or many existing Diamond Selectromatic Systems; is another example of why "Diamond Developed" means more economical power generation.

At your request, our Engineers will be pleased to evaluate the application of Monitormatic to your specific system. Call, write or wire for complete information.

DIAMOND POWER SPECIALTY CORPORATION, Lancaster, Ohio

DIAMOND SPECIALTY LIMITED, Windsor, Ontario

Circle No. 44 on Readers' Service Card



How to save ¼th the cost of modernizing your kitchen

Will you be ready to modernize when your home needs it? Buying U.S. Savings Bonds will help. This way you save money that will pay $4 worth of remodeling for every $3 you put aside.

Unlike your kitchen, United States Savings Bonds get better with age. Hold them until they mature, and you get back $4 for every $3 you put in. This means if you start buying Savings Bonds now, the money *plus* interest will be ready to modernize when you are. A modest plan will do it for you. Just 63¢ a day, for example, adds up in 40 months to $750 saved—and Savings Bonds worth $1000 at maturity. That's like getting a 25% discount on your new kitchen, or whatever room you decide to modernize.

Guaranteed in writing. The Government guarantees that you get 3¾% interest to maturity. A table on the back shows you exactly how your Savings Bond grows.

Why U.S. Bonds are good to buy and hold

You can save automatically on the Payroll Savings Plan, or buy Bonds at any Bank • You now earn 3¾% to maturity, ½% more than ever before • You invest without risk under a U.S. Government guarantee • Your Bonds are replaced free if lost or stolen • You can get your money with interest anytime you want it • You save more than money—you buy shares in a stronger America.

You save more than money with U.S. Savings Bonds. You help build a secure future in a peaceful world for yourself and your loved ones.

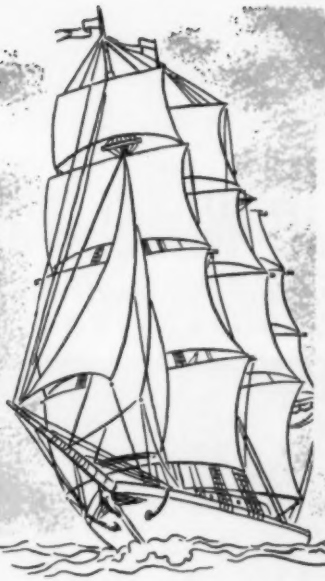
20th ANNIVERSARY 1941 1961

You save more than money with U.S. Savings Bonds

This advertising is donated by The Advertising Council and this magazine.

Why Rust-Oleum is different—

and what this difference, backed by 35 years of industry proof, means to you!



A Sea Captain developed it . . . Industry proved it!

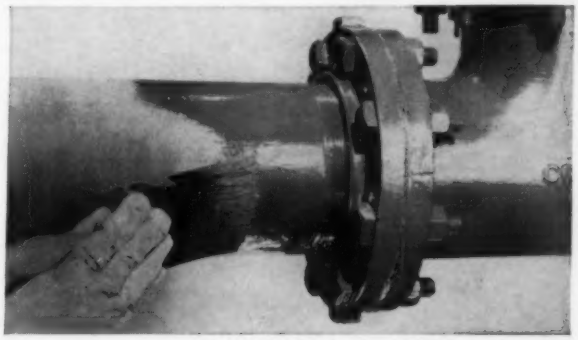
The original Rust-Oleum formula was developed nearly fifty years ago by Sea Captain Robert Fergusson, who became intrigued with the rust-stopping qualities of fish oil early in his career. Creating a *special treatment* for the fish oil, he used the *specially-processed fish oil* as the vehicle in combination with fine rust-inhibiting pigments. The result? A coating that actually *stopped rust* when applied directly over sound rusted surfaces, after scraping and wirebrushing to remove rust scale and loose rust. Possible, because the *specially-processed* fish oil penetrated the rust to bare metal. This was the birth of Rust-Oleum's *exclusive* 769 Damp-Proof Red Primer.

PROVED THROUGHOUT INDUSTRY FOR OVER 35 YEARS

Today, Rust-Oleum in its many systems and colors, has been proved throughout industry for over thirty-five years. This proof by leading industrial users is your assurance of savings in time, money, and metal. Economies made possible by the fact that Rust-Oleum 769 Damp-Proof Red Primer goes right over the sound rusted metal—usually eliminating costly surface preparations. And Rust-Oleum, in its various systems, resists rain, sun, fumes, heat, weathering, chemicals, etc., for lasting beauty over the years.

RUST-OLEUM NEW COLOR HORIZONS SYSTEM

The Rust-Oleum New Color Horizons System introduces a new coating concept to industry. It combines four important factors: (1) the ability to stop rust, (2) smart, modern color harmony, (3) the durability to last and last, (4) ease of application that saves time, money, and metal. See how this system can bring lasting beauty to your plant, machinery, equipment, pipes, tanks, structural steel, fences, etc. Write for complete information or contact your nearby Rust-Oleum Industrial Distributor. He maintains complete stocks for prompt service.



RUST-OLEUM®

There are imitations, but only *one* Rust-Oleum It is distinctive as your own fingerprint.

STOPS RUST!®

Circle No. 114 on Readers' Service Card

ATTACH TO YOUR LETTERHEAD

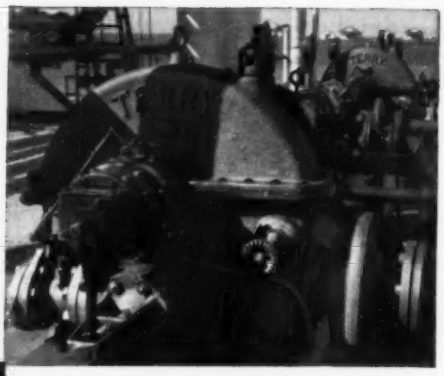
Rust-Oleum Corporation
2492 Oakton St., Evanston, Illinois

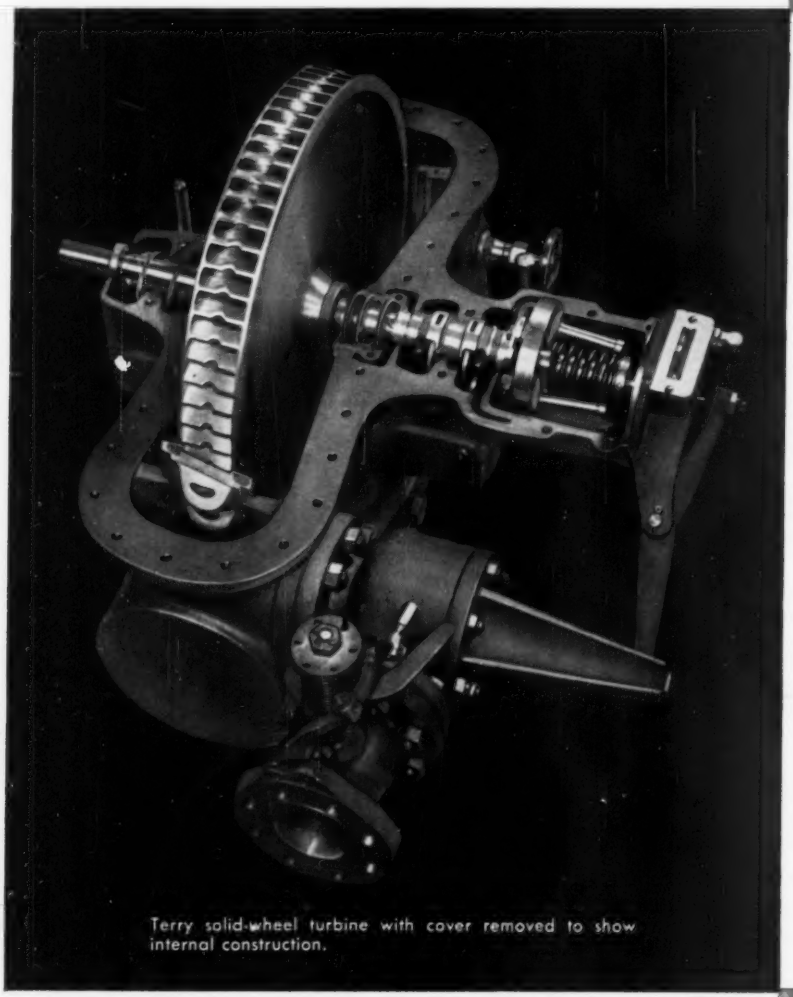
Please send me the following at no cost or obligation:

- ☐ New Color Horizons Systems Catalog featuring 110 actual color standards and 69 photo applications.
- ☐ Free test sample of Rust-Oleum 769 Damp-Proof Red Primer to be applied over sound rusted surface.
- ☐ Results of radioactive tracing study on Rust-Oleum fish oil penetration.

TERRY SOLID-WHEEL TURBINE

spells service continuity for mechanical drives





Terry solid-wheel turbine with cover removed to show internal construction.

For mechanical-drive applications, such as these, you will never find the equal of Terry solid-wheel turbines for built-in dependability. They are *designed* for trouble-free operation under the toughest service requirements.

The wheel, for example, is a single forging of special composition steel. Unlike a built-up wheel, there are no separate parts to loosen or work out. The blades can't foul since they are double-rim protected... with one-inch clearances at either side.

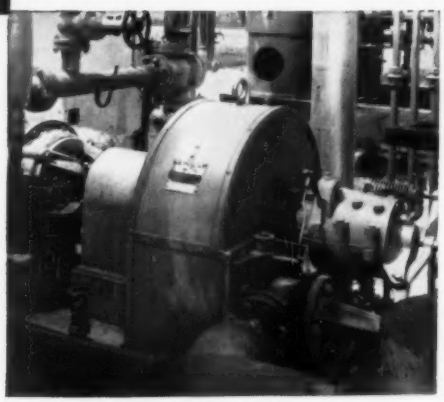
Any blade wear, which might occur after years of service, is of little consequence. As the power-producing action of the steam takes place on the curved surfaces at the backs of the buckets, wear does not materially affect horsepower or efficiency.

Specify Terry solid-wheel turbines for your next mechanical drives. They are available in capacities from 5 to 2,000 hp., speeds up to 10,000 rpm. Vertical turbines are built in sizes from 5 to 300 hp.

For full information about these reliable turbines, send for bulletin S-116.

THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

TERRY



TT-1216

Circle No. 124 on Readers' Service Card

STEPHENS-ADAMSON

CURVE CROWN®
STEPHENS-ADAMSON

PULLEYS

FEATURING "SQUEEZELOCK" HUB DESIGN

FOR GREATER BELT TRAINING EFFECT . . . REDUCED BELT WEAR

STURDY RIM CONSTRUCTION

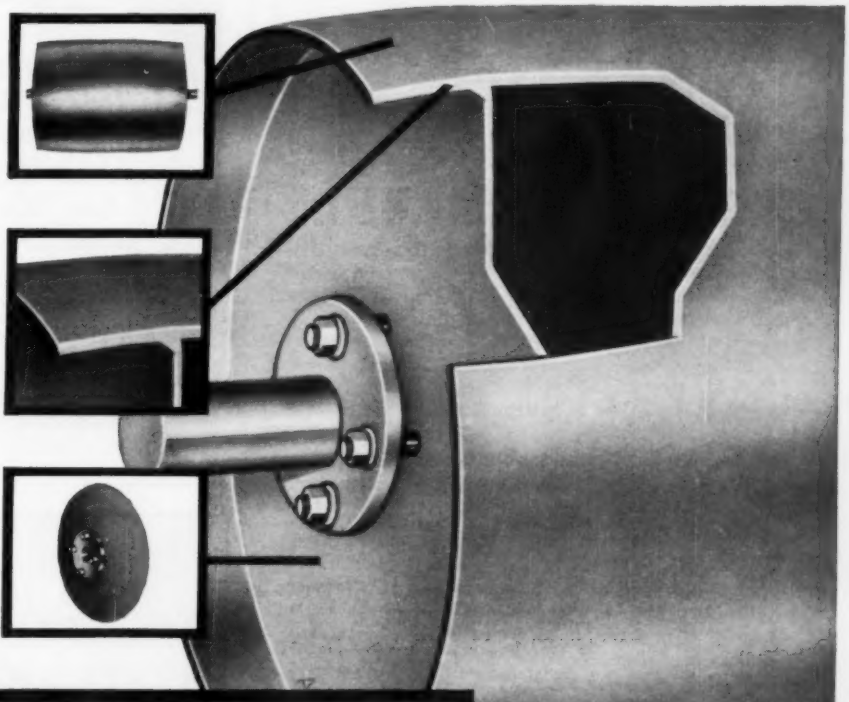
Pulley rims are made of one-piece construction, formed absolutely round under hydrostatic pressure. The only seam is machine-welded both inside and out to insure 100% penetration of welds.

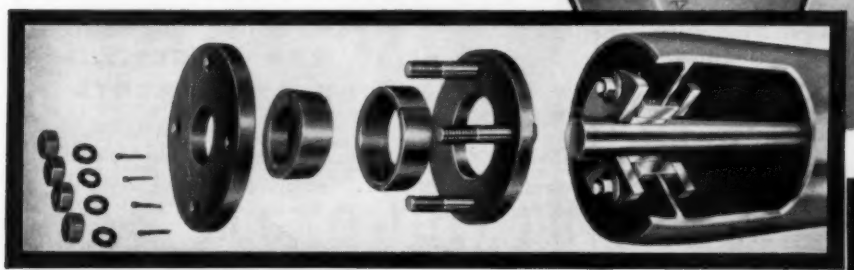
CURVE CROWN® DESIGN

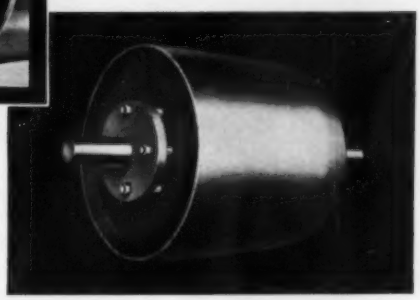
Curve Crown on outer ends of rim accurately formed. Revolutionary design eliminates conventional center peak — high point for belt stretch and wear —while increasing belt training effect more than 100%.

ACCURATE END PLATE ASSEMBLY

End plates are machined on both the O.D. and I.D. to insure concentricity between the bore and the outer rim. They are pressed into position for tight fit-up and submerged arc-welded for maximum efficiency.







"SQUEEZELOCK"® HUB Revolutionary design of "SQUEEZELOCK" Hub provides gripping power for full torque transmission without the use of keyways and eliminates distorting loads against pulley end plates. Two split tapered bushings are wedged against shaft and pulley end plates by two independent hub plates which are squeezed together by tightening four large diameter bolts.

Write for Bulletin 558

S-A®
ENGINEERED BULK HANDLING SYSTEMS
MATERIALS HANDLING PRODUCTS
SPEEDWALK PASSENGER CONVEYORS
TALMASTER BALL BEARING UNITS
SPHERCO BEARINGS & ROD ENDS

STANDARD PRODUCTS DIVISION
STEPHENS-ADAMSON MFG. CO.
GENERAL OFFICE & MAIN PLANT, 19 RIDGEWAY AVENUE, AURORA, ILLINOIS

PLANTS LOCATED IN: LOS ANGELES, CALIFORNIA • CLARKSDALE, MISSISSIPPI
BELLEVILLE, ONTARIO

Circle No. 119 on Readers' Service Card

Spherical

SHOCK TRAP® for WATER LINES

Eliminate water hammer and pipeline bursting. Save piping and plant costs with guaranteed surge limits.

PATENTS PENDING

PULSCO®

Designed primarily for shut-down or shut-off application, this unit is used in pumping plants, irrigation systems, fire control on rocket test stands, municipal water systems, etc. Of the water interface type, the Pulsco swirl principle reduces pressure and reduces shock and surge resulting from kinetic energy within the pipeline, this by compressing gas within the chamber and by friction through the swirl chamber.

Guaranteed not to recycle, this Pulsco Spherical Shock Trap is built for pressures to 200 PSIG and up. Sizes from 34 to 102 inches diam.

PULSCO *Bellows* SHOCK TRAP

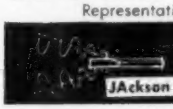
For AIRCRAFT AND MARINE FUEL LOADING SYSTEMS JET FUEL AND GASOLINE

PAT. PEND.

Take the "hammer" out of high velocity fuel lines — removes the danger of broken lines, meters, and overstressed loading equipment. Assure correct meter readings consistently with this Pulsco scientifically designed Bellows Shock Trap — the best for quick STOP and GO liquid lines.

SEND FOR BULLETINS AND APPLICATION DATA SHEET

Representatives in all principal cities



PULSATION CONTROLS CORPORATION

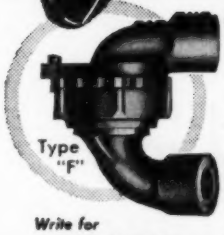
JAckson 5-6641 P.O. Box 769 • SANTA PAULA, CALIF.

Circle No. 187 on Readers' Service Card

WHEN PIPING MOVES

FLEXO-JOINTS

Offer the Flexibility of HOSE the Strength of PIPE



Type "F"

Write for complete information

For conveying pressures through moving pipe lines or to machinery or equipment while in motion, use dependable Flexo Joints. Complete 360° movement in either direction for pressures from gravity up . . . long wear—low maintenance cost. Four styles—standard pipe sizes ¼" to 3".

FLEXO SUPPLY CO., Inc.

4652 PAGE BLVD. ST. LOUIS 13, MO.

In Canada: S. A. Armstrong, Ltd., 1400 O'Connor Drive, Toronto 13, Ont.

Circle No. 54 on Readers' Service Card

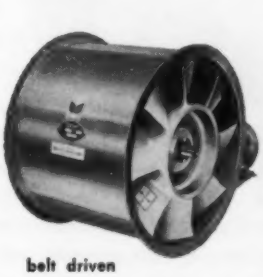
NEW 8 blade

Aerovent FANS

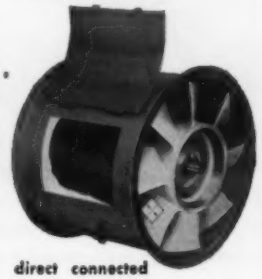
tubeaxial fans

high speed - high efficiency

Aerovent's new Tubeaxial Fan, designed around a new 8-blade "Macheta" Airfoil Axial Flow Propeller, offers top performance against medium pressures at speeds to 3450 RPM. Available in 16", 18", 24", and 30" diameters, this unit combines speed, stamina and modern functional design. Easily installed in present ductwork or engineered to new construction, it's the right answer for resistances to 4" SP. Another outstanding development from Aerovent—America's finest industrial fans and air equipment.



belt driven



direct connected

WRITE FOR FREE BULLETIN 350

Air deliveries of Aerovent equipment determined in accordance with established and accepted codes and guaranteed by manufacturer.

CERTIFIED PERFORMANCE

Aerovent FANS

Aerovent

FAN COMPANY, INC.

ASH and BEACH STS. PIQUA, OHIO

Circle No. 3 on Readers' Service Card

MECHANICAL ENGINEERING

March, 1961 CARD INDEX Vol. 83, No. 3

OPPORTUNITIES

positions open • positions wanted • equipment, material, patents, books, instruments, etc. wanted and for sale • representatives • sales agencies • business for sale • partnership • capital • manufacturing facilities

ANSWERS to box number advertisements should be addressed to given box number, care of "Mechanical Engineering," 29 West 39th St., New York 18, N. Y.

RATES: Classified advertisements under this heading in MECHANICAL ENGINEERING are inserted at the rate of $4.50 a line. $2.00 a line to members of ASME. Seven words to the line average. A box number address counts as one line. Minimum insertion charge, 5 line basis. Display advertisements carried in single column units of multiples of one inch at flat rate of $45.00 per inch per insertion. Copy must reach us not later than the 10th of the month preceding date of publication.

POSITIONS OPEN

ENGINEER

Immediate opening for young, ambitious electro-mechanical engineer for plant process development in organization with outstanding growth history in flexible plastic packaging. EE or ME degree with up to 10 years' experience. Future limited only by ability.

Located near Greenville, South Carolina. New, air-conditioned plant in foothills of Great Smoky Mountains with its attendant excellent recreational features.

Send resume including salary requirements to: Mr. R. A. Mattson

W. R. GRACE & CO.
CRYOVAC DIVISION
P. O. Box 233, Simpsonville, S. C.

Use a CLASSIFIED ADVERTISEMENT
For QUICK RESULTS

DEVELOPMENT AND SALES ENGINEERS

VALVES and mechanisms for critical high-pressure, high-temperature services in the growing marine, petroleum, process and power fields—including nuclear power.

CONTACT J. M. Evan, Edward Valves, Inc., subsidiary of Rockwell Manufacturing Company, 1200 W. 145 St., East Chicago, Indiana.

SENIOR PROJECT ENGINEER

Major manufacturer of industrial chemicals has responsible position available in Chicago headquarters office for qualified individual. Prefer mechanical and/or chemical engineer with substantial design experience in plant construction work possibly with consulting engineering firm. Must be able to work with very limited direction and make his own decisions. High academic standing in engineering school essential. *Unusual potential for development in growth company. Attractive salary with many personnel benefits.* All replies confidential. No reference checking without specific approval. Our engineering staff knows of this opening. Please send detailed resume.

Address CA-7132, care of "Mechanical Engineering."

WANTED:
YOUNG ENGINEER TO START AT PLANT MANAGER LEVEL

Requirements

1. Not over 30 years old.
2. Scholastic record in top 25% of graduating class.
3. Good record of accomplishment in previous employment.
4. Must be willing to put forth the extra effort to be promoted quickly.

Information about the job and our company

1. Minimum starting pay $8,000. Applicants with outstanding record will start at a higher salary commensurate with experience and ability.
2. We are a leading producer of flexible urethane foams for the furniture manufacturing industry.

   This unusual opportunity for a young engineer is due to our phenomenal growth in an industry that is expanding very rapidly.
3. Present employment will be in Richmond, Va. We have additional plants located in the following cities:

High Point, N.C. — Chattanooga, Tenn.
Hickory, N. C. — Memphis, Tenn.

E. R. CARPENTER COMPANY, INC.
7th & Decatur Sts. — Richmond, Virginia

A SUGGESTION *to engineers*
looking for broader responsibilites in the jet engine field

Our current programs are aimed at creating next-generation systems throughout the power spectrum of military and commercial turboshaft and turbojet engines. Our business plans are aggressive. By giving you broader responsibilities we improve our own growth plan. We'd welcome a chance to learn about your desire for more responsibilities in any of the following areas:

Jet Engine Component Design Engineering / Engine Test and Evaluation / Engine and Component Performance Analysis / Engine Systems Analysis / Information Retrieval Systems Development / Stress Analysis.

Please write informally, or forward your resume in professional confidence to Mr. Mark Peters, Dept. 41-MD.

FLIGHT PROPULSION DIVISION

GENERAL ELECTRIC

Cincinnati 15, Ohio

Nuclear Scientists and Engineers:

A "Different" kind of Opportunity at The Knolls Atomic Power Laboratory

Selective program expansion—and commencement of applied research projects in new and promising areas of nuclear reactor and power plant technology—have generated several new openings of unusual potential.

The Laboratory can offer immediate placement in:
Electrical systems design/Instrumentation controls design/Power plant equipment design/Reactor nuclear analysis/Theoretical physics (PhD)/Experimental physics/Statistical methods application (PhD)/Reactor mechanical design/Hydro-thermal engineering computations/Numerical analysis.

Masters Degree Program—KAPL is now considering recent graduates in ME, Met, Met E, ChE, Physics, EE, and Nuclear E for its masters degree program in nuclear engineering in conjunction with Rensselaer Polytechnic Institute. Applicants should have strong interest in the nuclear field and must have graduated in upper 10% of their class. Selection of candidates will be completed by early Spring; classes begin September, 1961. Write for further details.

Forward your resume in confidence to Mr. F. W. Snell, Dept. 41-MD.

Knolls Atomic Power Laboratory
OPERATED FOR A.E.C. BY
GENERAL ELECTRIC

(U. S. Citizenship Required)

Schenectady, New York

NEW OPENINGS at Bausch & Lomb

MECHANICAL ENGINEERS

Several openings are available in the Mechanical Design Section where an engineer has project responsibility from specifications to a saleable product. The products involved are mechanical—electrical—optical in nature. These positions require board design, inter-plant engineering coordination, drafting supervision and production assistance.

PROJECT ENGINEERS

The Military Products Department has several challenging openings for Project Engineers. These men will have broad project responsibility in the area of optical and electro-optical systems. Should be familiar with Military R.&D. Specific optical experience not required. Educational background may be in either Electrical or Mechanical Engineering or Physics.

MATHEMATICIAN

M.S. or Ph.D. to be responsible for basic research in the Thin Film area. Also openings for Mathematicians with an interest in Computors and Programming and in Lens Design.

OPTICAL ENGINEERS

Section Head with mature background in optical, mechanical, electro-optical or related systems for military projects, with primary emphasis on optical system design and hardware follow-through. (Career opportunities also available for qualified optical engineering section personnel.)

PRODUCTION ENGINEER

Department Head for machine and tool design with broad experience in mechanical and electro-mechanical manufacturing. Several openings also available for Production Engineers in the areas of Time Study, Process Engineering, and Quality Control.

LIVE IN ROCHESTER

. . . in the heart of upstate New York vacation country. Rochester is noted for its fine schools and the University of Rochester (with its Institute of Optics), beautiful homes and gardens, outstanding cultural advantages, and high ratio of professional residents.

Please send resume to: H. A. Frye, Professional Employment
18 Bausch Street, Rochester 2, N. Y.

Bausch & Lomb Incorporated

This four-cryotron flip-flop can be switched in *two billionths of a second.* It was developed by an IBM team investigating the possibilities of low-temperature devices for basic binary storage in digital computers.

IBM scientists and engineers designed the flip-flop around a primary law of low-temperature physics: A superconductive metal loses its superconductivity in the presence of a magnetic field. In the IBM device, a small control current is used to destroy the superconductivity of one of two parallel lines. This sets up a resistance in the first line and causes current to switch to the second.

The new flip-flop offers another advantage in addition to speed. Its eight layers of thin metallic and insulation films operate in a temperature range where chemical deterioration is nonexistent. As a result, the device should have an unusually high degree of reliability.

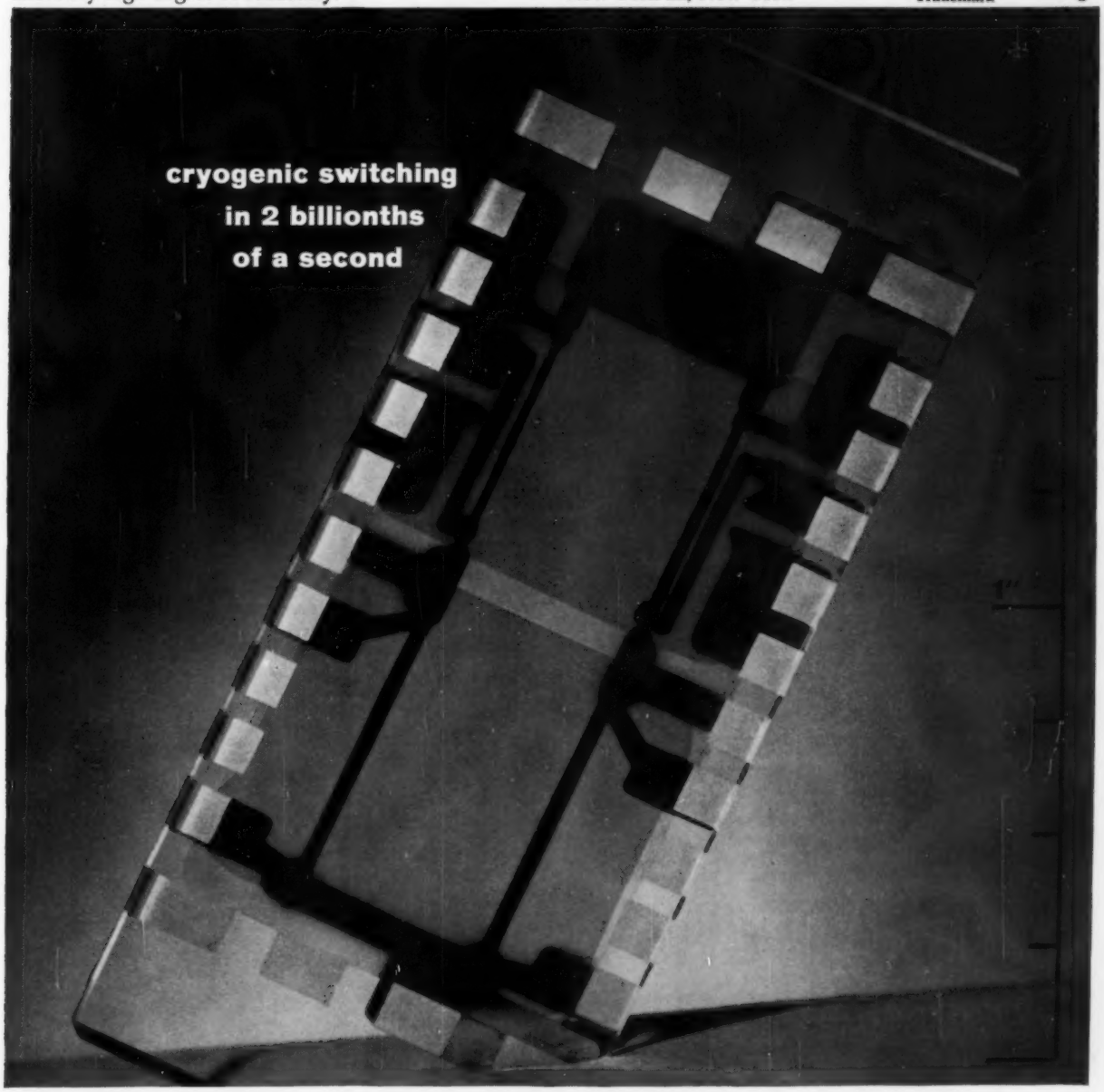
Creative careers start here. A good deal of this project's success came from the creative interplay of different technical areas. IBM physicists and mechanical and electrical engineers worked together to develop new films, improved vacuum equipment and more reliable test circuits.

Perhaps you'd like to work . . . and grow . . . in a professionally stimulating atmosphere like this. You may be interested in the progress IBM is making in such areas as solid state, magnetics or IBM Tele-Processing.* If you have a degree in engineering, mathematics, or one of the physical sciences, plus experience in your field, write, briefly describing your background, to:

Manager of Technical Employment
IBM Corporation, Dept. 598-D
590 Madison Avenue
New York 22, New York

IBM

*Trademark ®



ENGINEERS

Send us your telephone number . . . it could mean a Connecticut or Florida future!

I am interested in receiving more information concerning Pratt & Whitney Aircraft career opportunities in Connecticut or Florida. My experience has been in the following fields:

- ☐ Power Plant System Analysis
- ☐ Power Plant Test Engineering
- ☐ High Temperature-Elect.-Mach.
- ☐ Instrumentation & Control
- ☐ Technical Report Writing
- ☐ Project Material Control
- ☐ Structural Analysis
- ☐ Numerical Analysis
- ☐ Reactor Shielding
- ☐ Mechanical Design
- ☐ Applied Physics
- ☐ Heat Transfer
- ☐ Nuclear Engineering
- ☐ Gas Dynamics
- ☐ Quality Control
- ☐ Rocket & Turbojet Control Systems Test Engineers

My engineering degree is.....

Total years of engineering experience.....

You can reach me at.....(telephone number)

Most convenient time to call would be between.....and.....

Name.....

Address.....

City.....State.....

Pratt & Whitney offers unusual opportunities for engineers and scientists to work on advanced propulsion system development programs.

You can discuss these advanced projects with our engineering supervision on a confidential basis—in the privacy of your home. Mail the coupon above—we may want to telephone you. You will get the facts about engineering opportunities at our Florida Research and Development Center, East Hartford, Connecticut facility and our Connecticut Aircraft Nuclear Engine Laboratory (CANEL), Middletown, Connecticut.

If you are looking toward tomorrow, mail this coupon today to:

Mr. P.R. Smith
Office 70
Pratt & Whitney Aircraft
366 Main Street
East Hartford 8, Conn.

or:

Mr. J. W. Morton
Office 70
Pratt & Whitney Aircraft
West Palm Beach
Florida

or:

Mr. L. T. Shiembob
Office 70
CANEL
Box 611
Middletown, Conn.

PRATT & WHITNEY AIRCRAFT

DIVISION OF UNITED AIRCRAFT CORPORATION

POSITIONS OPEN FOR INQUIRING MINDS IN MANUFACTURING RESEARCH ENGINEERING!

Engineering Special Projects

Bendix of Kansas City, Missouri needs three Manufacturing Research Engineers to do original work with new materials, and close, more exacting work with ordinary materials—Minds that will inquire into the many branches of technology and bring together that combination of techniques capable of producing a unique product. As a Prime Contractor for the Atomic Energy Commission, our function is to give the Weapon Designer the greatest possible latitude in exploiting new materials and techniques. We do this by paralleling his design work with advanced development of manufacturing processes during the design phase. The control of processes must frequently be so precise that automation is required for that reason alone—production quantity notwithstanding.

Engineers who can fill these positions must combine original thought with solid training n the basic physical sciences. They must be able to combine the reasoning of several disciplines in the development of a solution. Minimum requirements include:

- *Bachelor's Degree in Mechanical, Chemical or Electrical Engineering.
- *Strength in one or more of the following fields: subminiature transformer and toroid production, plastic and rubber formulation and fabrication, sheet metal fabrication, heavy and small parts machining, and fabrication and assembly of precise and delicate electrical and electronic assemblies requiring special environmental facilities.

These are responsible positions for engineers who are qualified to do original and creative work, and who can demonstrate by a record of past professional accomplishment that they possess this ability. Ours is one of the nation's most vital industries. We offer unusually generous company benefits in a Midwestern community which is famous for its beauty and low cost-of-living. All replies will be strictly confidential.

For personal interview send resume to
Mr. K. L. Beardsley
Box 303-TM

THE Bendix CORPORATION

KANSAS CITY DIVISION
95th & Troost, Kansas City 41, Missouri

POSITIONS OPEN

POSITIONS AVAILABLE for man to teach courses in engineering drawing and descriptive geometry. M.S. preferred. Opportunity for graduate work. Location Midwest, salary and rank dependent on qualifications. Address CA-7108, care of "Mechanical Engineering."

Our expansion provides opportunity for enterprising MECHANICAL ENGINEERS, both experienced and recent graduates, in the field of central station and industrial power house equipment. Positions are available in sales, machine design, product development, and administration. Stock Equipment Company, 731 Hanna Building, Cleveland 15, Ohio.

MECHANICAL ENGINEER. Excellent opportunity at Project Engineer level for BSME with minimum 10 years' experience, preferably in heating, ventilating, and air conditioning. Position permanent and open immediately with established Midwest consulting firm designing industrial plants, power houses, public buildings, office buildings, laboratories. Moving expenses paid. Address CA-7130, care of "Mechanical Engineering."

EXECUTIVE ENGINEER with strong academic background and experience in modern metal processing techniques, metallurgy, orging, foundry and welding methods. Knowledge of code pressure vessel, exchanger, process and nuclear equipment design desirable. Challenging opportunity and excellent living area. Location northwest. Reply with resume. Address CA-7133, care of "Mechanical Engineering."

PROCESS ANALYSIS—Senior Engineer, preferably with advanced degree in physics, mechanical, or chemical engineering to conduct research on the analysis and control of glass container manufacturing processes. Excellent working conditions in new research center just completed near Plainfield, Illinois, 35 miles southwest of Loop. Write to: R. P. Eichhorn; Research & Development Department, Hazel-Atlas Glass Division, Continental Can Co., Inc., Plainfield, Illinois.

MECHANICAL SPECIFICATIONS WRITER. Capable man with broad experience in specification writing for mechanical phase of building construction work is sought immediately by large Midwest consulting firm. Moving expenses paid. Resume showing educational background, experience, personal qualifications should be sent. Address CA-7145, care of "Mechanical Engineering."

CRYOGENIC ENGINEER FOR PROJECT WORK. Previous experience as a process or project engineer needed—familiarity with metal joining techniques helpful but not necessary. Opportunity to grow with company. Address CA-7140, care of "Mechanical Engineering."

ENGINEER to design cryogenic hardware requires heat transfer calculations—fabrication know how for all types of metal joining, forming and cutting operations plus high vacuum techniques. Address CA-7141, care of "Mechanical Engineering."

.S. Army Chemical Corps Proving Ground. Mechanical Engineer, GS-12, $8,955. Will serve as Chief, Mechanical Engineer Section supervising small group of engineers and draftsman in the design and development of novel and unorthodox mechanical devices, apparatus, and equipment of major importance, as required for use in the installation's testing program. Three years experience demonstrating an extensive knowledge of engineering principles and their application and either the ability to direct and coordinate professional engineering activities of importance, or a high degree of technical competence in the original successful solution of very difficult and complex engineering problems in connection with important technical research, design, development, planning, or comparable functions required. For further information regarding this position write Civilian Personnel Officer, Dugway Proving Ground, Dugway, Utah.

BECHTEL

San Francisco

Refinery and Chemical Division offers immediate employment opportunities for mechanical, chemical or instrumentation engineers capable of assuming responsibility on design of major petrochemical, refinery or similar processing units.

Relocation allowances cover moving costs plus transportation reimbursement for you and members of your family. If you have an interest in a San Francisco assignment, please send a resume of experience, including your present and required salary, to George I. Copeland, Manager of Personnel.

Bechtel
Corporation
220 Montgomery Street
SAN FRANCISCO

Excellent Opportunity for Instructors in

TOOL DESIGN
MACHINE DESIGN

with ME or IE background. Stimulating work and professional development on new, growing campus of two-year college of State University of N.Y. accredited by MSA and ECPD. B.S. required; Master's degree and/or teaching experience desirable. Starting salaries to $7500 depending on experience, background, etc. Write full details to Mr. Benjamin Davis, Head, Mechanical Dept., Mohawk Valley Technical Institute, Utica, N.Y.

DEVELOPMENT or PROJECT ENGINEERS

Challenging position in progressive U. S. company, recognized leader in its field. To qualify for this position, you must have:

Enthusiasm to develop new products.
Imagination to visualize new approaches.
Ability to overcome problems.

Mechanical Engineering Degree (or equivalent) required. Minimum of eight to ten years' development experience in pipe valves, fittings and allied fields preferred, but main requirement is creative ability.

Please reply by letter giving full details of education, experience and goals. Responses will be treated in confidence.

Address CA-7137, care of "Mechanical Engineering."

MECHANICAL ENGINEERS

Project level positions open in both Chicago and New York offices of established consulting engineering organization. Minimum qualifications: BSME degree, power option, 10 years experience in design of steam-electric generating stations; ability to perform all calculations and write specifications for equipment, controls and installation contracts. Duties include supervision and manpower control of mechanical design-drafting group. Balanced personality required for client contact and internal coordination. Career opportunity and possibility for eventual ownership participation. Submit two copies of complete resume.

Address CA-7143, care of "Mechanical Engineering."

POSITIONS WANTED

MECHANICAL ENGINEER, advanced degree. Experienced in development and design of automated machinery, mechanism, hydraulic systems and in production—also on supervisory level. Ready to assume responsibility. Address CA-7136, care of "Mechanical Engineering."

MECHANICAL ENGINEER: BME, age 36. Eight years heavy custom type equipment including project design responsibility along with assistance and direction thru erection and operation. Year and a half Missile Handling equipment. Desires responsible project engineering position. Address CA-7134, care of "Mechanical Engineering."

EMPLOYMENT AGENCIES AND SERVICE BUREAUS

ATOMIC PERSONNEL, INC.

WRITE FOR APPLICATION OR SEND RESUME
•
CONFIDENTIAL HANDLING

A NATIONAL EMPLOYMENT AGENCY for the *NUCLEAR FIELD*
•
NO CHARGE TO INDIVIDUALS

Suite 1207-P, 1518 Walnut St., Phila. 2, Pa.

SALARIED POSITIONS—$6,000 to $35,000. We offer the original personal employment service (established 50 years). Procedure of high standards individualized to your personal requirements. Identity covered. Particulars—R. W. Bixby, Inc., 662 Brisbane Bldg., Buffalo 3, N.Y.

PLANT PERSONNEL, ENGINEERS, DESIGNERS—Draftsmen, Chemists, and Metallurgists, E. G. Stroud, Member ASME and President of Cleveland Engineering Agency Co., 2132 E. 9th St., Cleveland 15, Ohio, will help you find positions or men.

SALARIED PERSONNEL $6,000 to $35,000. This nation-wide service successful since 1927 finds openings in your field. Sells your abilities: arranges contacts. Present position protected. Write for details—Jira Thayer Jennings, P. O. Box 674, Manchester, Vermont.

REPRESENTATIVES AVAILABLE

MANUFACTURERS REPRESENTATIVE desires additional industrial equipment account for exclusive sales coverage. Engineering sales office located Philadelphia area covering Pennsylvania, New Jersey, Maryland and Delaware. Address CA-7129, care of "Mechanical Engineering."

ENGINEER Sales Representative, established, can represent equipment manufacturer selling to Power, Process & large HVAC fields. Exclusive territory. Reply with complete catalogs to Plant & Process Equipment Co., Box 3082, St. Louis 30, Mo.

CAREER OPPORTUNITIES FOR MECHANICAL ENGINEERS

WITH LEADING CHEMICAL COMPANY

Project Engineering and Chemical Plant Design

Work involves design of chemical processing plants including apparatus and equipment, plant layout, specifications, procurement and construction through plant startup. Must have at least 5, no more than 10 years of related experience and a B.S. degree in mechanical engineering from an accredited college. Location in Wilmington, Delaware.

These positions are with Hercules Powder Company, a large diversified chemical company whose operations are international. However, at Hercules a man's individual contribution will not be overlooked.

Hercules has had a consistent rate of growth. This, together with a policy of promotion from within, provides excellent opportunities for the qualified technical man.

Write to Mr. Malcolm C. Moore • Technical Employment
HERCULES POWDER COMPANY
INCORPORATED
Hercules Tower, 910 Market Street • Wilmington 99, Del.

GR61-5

Answers to box number advertisements should be addressed to given box number, care of "Mechanical Engineering." 29 West 39th Street New York 18, N. Y.

the new MICRO-MASTER® 35mm Camera-Projector by K&E

FIRST with fluorescent lighting. Eliminates hot, troublesome reflector floods, gives better light.

FIRST with curved-field lens. Assures last bit of resolution out of image for highest quality blowbacks.

FIRST with vacuum subject-holder. Holds copy perfectly flat from edge to edge, assures sharper negatives every time.

FIRST with motor-driven projector. Film moves backward or forward for projection at the touch of a button.

FIRST with backlighting. Increases contrast, simplifies reproduction of soiled or two-sided originals.

FIRST with 5-second conversion. From camera to projector in 5 seconds—simple operation assures maximum versatility and output.

A host of technical firsts and *finests* make this the most efficient 35mm unit yet perfected. Specifically tailored for *engineering* miniaturization and reproduction, the new MICRO-MASTER 35mm Camera-Projector enables greater accuracy than any other 35mm unit. The more you learn about this new unit, the more you'll want it. To get the full story, see your local K&E dealer, or fill out and mail the coupon below:

K+E

KEUFFEL & ESSER CO.

NEW YORK • HOBOKEN, N. J. • DETROIT • CHICAGO
MILWAUKEE • ST. LOUIS • PHILADELPHIA • DALLAS • DENVER
SAN FRANCISCO • LOS ANGELES • SEATTLE • MONTREAL

KEUFFEL & ESSER CO., Dept. ME-4, Hoboken, N. J.

Gentlemen:

Please send me complete descriptive literature on the new MICRO-MASTER® 35mm Camera-Projector by K&E.

Name & Title: _____

Company & Address: _____

_____ 4054

Circle No. 79 on Readers' Service Card

CONSULTING SERVICE

Manufacturers of Equipment not included

RATES: One-inch card announcements inserted at rate of $30 each issue, $25 per issue on yearly contract

BLACK & VEATCH
CONSULTING ENGINEERS
Electricity—Water—Sewage—Gas—Industry
Reports, Designs, Supervision of Construction
Investigations, Valuation and Rates
1500 Meadow Lake Parkway, Kansas City 14, Mo.

The Huljian Corporation
ENGINEERS • CONSTRUCTORS • CONSULTANTS
POWER PLANT SPECIALISTS
(Steam, Hydro, Diesel)
UTILITY • INDUSTRIAL • CHEMICAL
1200 N. BROAD ST., PHILA. 21, PA.

PIONEER SERVICE & ENGINEERING CO.
Consulting & Design Engineers
Public Utilities — Industrials
Purchasing — Construction Management
231 So. La Salle St. Chicago 4

CRYSTAL LAKE ENGINEERING COMPANY
engineers
Design—Develop—Manufacture
Intricate—Assemblies—Products
Miniature Precision Grinding
Write or Phone 459-3500
10 Gates St. Crystal Lake, Ill.

GUY B. PANERO ENGINEERS
CONSULTING ENGINEERS
630 Third Avenue
New York 17, New York
Tel: YUkon 6-4949

SARGENT & LUNDY
ENGINEERS
Consultants to the Power Industry
STUDIES • DESIGN • SUPERVISION
140 South Dearborn Street, Chicago 3, Ill.

GILBERT ASSOCIATES, INC.
Engineers and Consultants
Design and Supervision of Construction
Mechanical • Electrical • Nuclear
Sanitary • Chemical Laboratory
Business and Economic Research
New York **READING, PA.** Washington

PROPANE GAS PLANTS
ANHYDROUS AMMONIA PLANTS
Designed and Installed
PEACOCK CORPORATION
Box 268, Westfied, N. J.

STANLEY ENGINEERING COMPANY
Consulting Engineers
Hershey Building, Muscatine, Ia. — 208 S. LaSalle Street, Chicago 4, Illinois
1154 Hanna Building, Cleveland 15, Ohio

HARZA ENGINEERING COMPANY
CONSULTING ENGINEERS
Hydroelectric Plants and Dams
Transmission Lines
Flood Control Irrigation
River Basin Development
400 West Madison Street Chicago 6

An announcement in this section will acquaint others with your specialized practice.

SUMCO ENGINEERING, INC.
ENGINEERS • CONSULTANTS • CONTRACTORS
All phases of Chemical cleaning
CALDWELL, NEW JERSEY

JACKSON & MORELAND, INC.
JACKSON & MORELAND INTERNATIONAL, Inc.
Engineers and Consultants
Electrical—Mechanical—Structural
Design and Supervision of Construction for
Utility, Industrial and Atomic Projects
Surveys—Appraisals—Reports
Technical Publications
BOSTON — WASHINGTON — NEW YORK

SVERDRUP & PARCEL
Engineers—Consultants
Design • Construction Supervision
Steam and Hydroelectric Power Plants
Power Systems • Industrial Plants
Studies • Reports
San Francisco ST. LOUIS Washington

The above consultants are available

to work out solutions

to your engineering and management problems

NEW BELL LABORATORIES RESEARCH FORESHADOWS COMMUNICATIONS AT OPTICAL FREQUENCIES

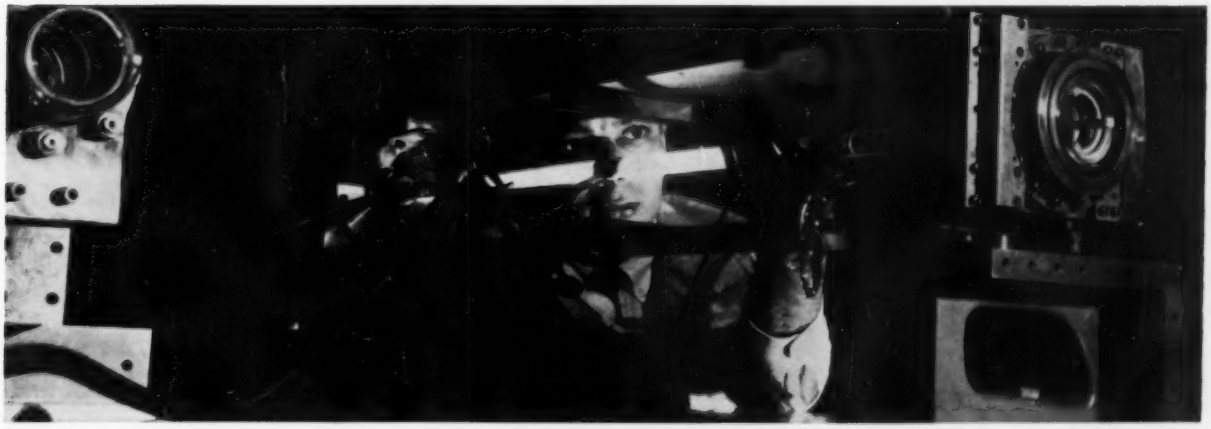
A revolutionary new device, the continuously operating Optical Gas Maser, now under investigation at Bell Telephone Laboratories, foreshadows a whole new medium for communications: light.

Light waves vibrate at frequencies tens of millions of times higher than broadcast radio waves. Because of these high frequencies, a beam of light has exciting potentialities for handling enormous amounts of information.

Now for the first time, Bell Laboratories' new Optical Gas Maser continuously generates light waves that are "coherent." That is, the light waves move in phase as seen looking across the beam.

With further research, it is expected that such beams can be made to carry large amounts of information. The beams can be transmitted through long pipes. They can be projected very precisely through space, and might be used for communications between space vehicles.

Research with coherent light is another example of how Bell Laboratories prepares ahead for communications needs.



The Optical Gas Maser (above) was first demonstrated at Bell Telephone Laboratories. Heart of unit is a 40-inch tube containing helium and neon. Interaction between gas atoms produces a continuous, coherent beam of infrared light that may one day be used in communications.

BELL TELEPHONE LABORATORIES

WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT

Circle No. 21 on Readers' Service Card

INDEX TO ADVERTISERS

* The asterisk indicates that firm has product catalog in the 1961 Mechanical Catalog.

Your attention is directed to

Advertisers appearing in previous 1961 issues

*Air Preheater Corp.
All American Tool & Mfg. Co.
American Felt Co.
*American Pulverizer Co.
*American Standard
Industrial Division
*Associated Spring Corp.
Autonetics, A. Division of North
American Aviation, Inc.

*Babcock & Wilcox Co.
Boiler Division
Tubular Products Div.
Bahnson Co.
Bendix Computer Division
*Buell Engineering Co.

Chace, W. M., Co.
Chapman Valve Mfg. Co.
*Chicago Bridge & Iron Co.
Clarage Fan Co.
Clearprint Paper Co.
*Combustion Engineering, Inc.
*Crane Co.

*Everlasting Valve Co.

Fiske Bros. Refining Co.
Lupriplate Div.

General Motors Research Labs.
German American Chamber of Commerce
*Golden-Anderson Valve Specialty Co.
*Griscom-Russell Co.

Hamilton, Alexander, Institute

Jeffrey Mfg. Co.
Jordan Corp.
Div. OPW Corp.

Kano Laboratories
*Keeler, E., Co.
Kellogg, M. W., Co.
Kennedy Valve Mfg. Co.
King Engineering Co.

Lefax Publishers
Lenape Hydraulic Pressing & Forging Co
Lupriplate Div.
Fiske Bros. Refining Co.
Lukens Steel Co.

McGraw-Hill Book Co.
Monsanto Chemical Co.

Nagle Pumps, Inc.
Nalco Chemical Co.
Niagara Blower Co.
*Norwalk Co.

*PIC Design Corp.
Sub. Benrus Watch Co.
Pace Engineering Co.
Pangborn Corp.
Philadelphia Gear Corp.
*Philbrick, George A., Researches, In
Pipe Fabrication Institute

Raybestos Manhattan, Inc.
Manhattan Rubber Div.
*Reliance Gauge Column Co.
Rockford Clutch Div.
Borg-Warner

Stewart, F. W., Corp.
Stock Equipment Co.
*Syntron Co.

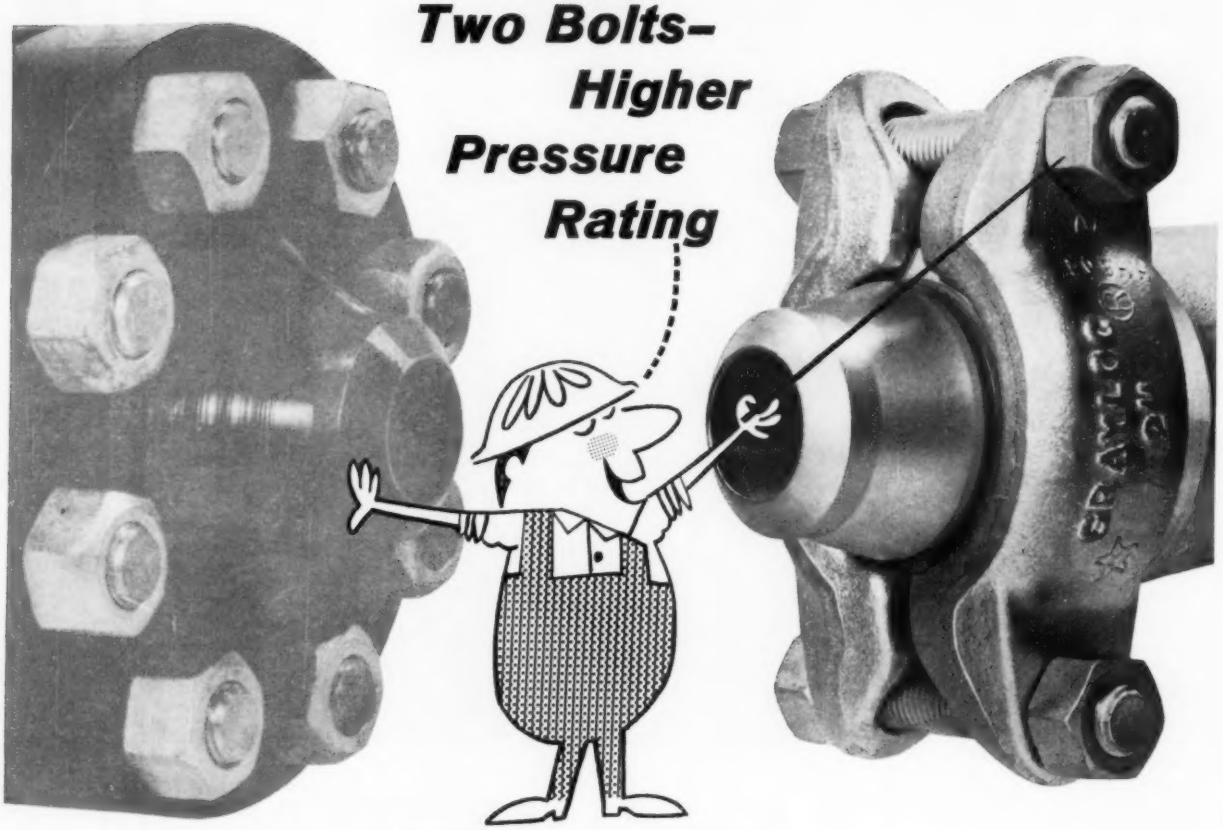
*Twin Disc Clutch Co.

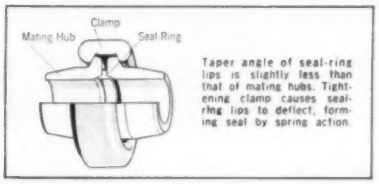
*Union Iron Works
Div. Riley Stoker Corp.
United States Graphite Co.
Div. Wickes Corp.

Williams Gauge Co.
Wood, John, Co.

*Yuba Consolidated Industries, Inc.
Adsco Division

Only Two Bolts– Higher Pressure Rating





GRAYLOC® Pipe Connections can be assembled in less than 1/3 the time required for a comparable flanged assembly — yet GRAYLOC Connections provide as much as twice the maximum pressure rating.

An all steel assembly, GRAYLOC incorporates a pressure aided seal that can be quickly and easily disconnected — the seal ring is completely re-usable. GRAYLOC connections are smaller in size and lighter in weight than any other comparably rated connection.

GRAYLOC Connections are manufactured in standard stock sizes from 1″ to 30″, with special sizes available on request. Highly corrosion resistant metals are available on short notice.

GRAYLOC Pipe Connections can save you assembly and maintenance time, space and money. Write today for specific engineering information and your copy of the new GRAYLOC catalog.

GRAYLOC SALES DIVISION

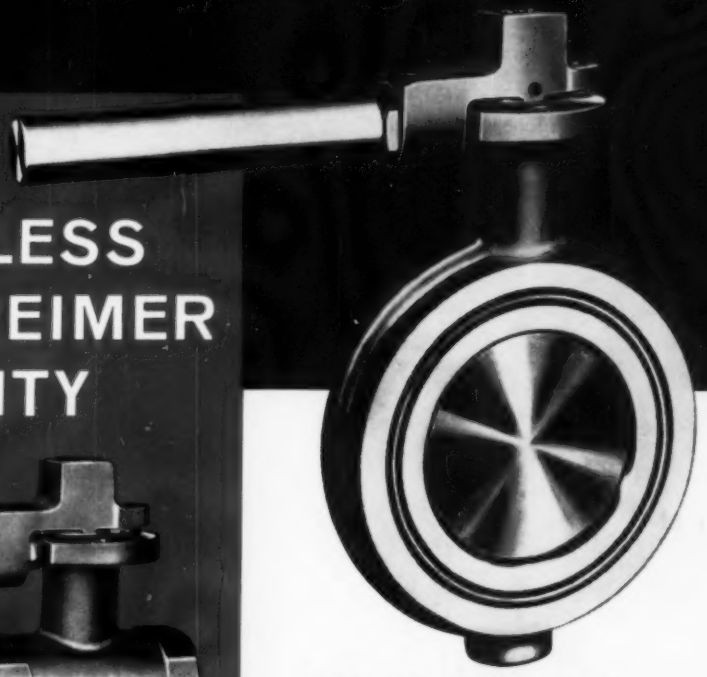
GRAY Tool Company

6111

P. O. BOX 2291 • HOUSTON 1, TEXAS • RIverside 7-1240

Circle No. 64 on Readers' Service Card

NEW Butterfly Valve!



MATCHLESS LUNKENHEIMER QUALITY

FIG. 4026N

Complete Valve with Ends on Casting.
2"-6".
Screwed End.

FIG. 4150N

(Rubber-Lined: Fig. 4151R) Valve Elements Only.
2"-18". Screwed, Welded, Grooved, or Flanged Ends Supplied Separately to Fit Your Pipe Connections.

L-361-23

W. P. 150 psi.

- QUICK OPENING
- POSITIVE CLOSURE
- NICKEL-PLATED CAST IRON
- STAINLESS STEEL TRIM
- "O" RING SEALS

New Lunkenheimer Butterfly Valves are compact and lightweight, easy to install on any line in a fraction of the space required by standard gate or plug valves. A quarter-turn of the stem opens the disc full or closes it tight. No lubrication is required, and "O" Ring seals provide positive shut-off in either vacuum or pressure service. These new Butterfly Valves are made to traditional Lunkenheimer standards of quality. WRITE for new Catalog 613 or call your Lunkenheimer distributor today for full information on the new Lunkenheimer Butterfly Valve line . . . available now for immediate delivery.

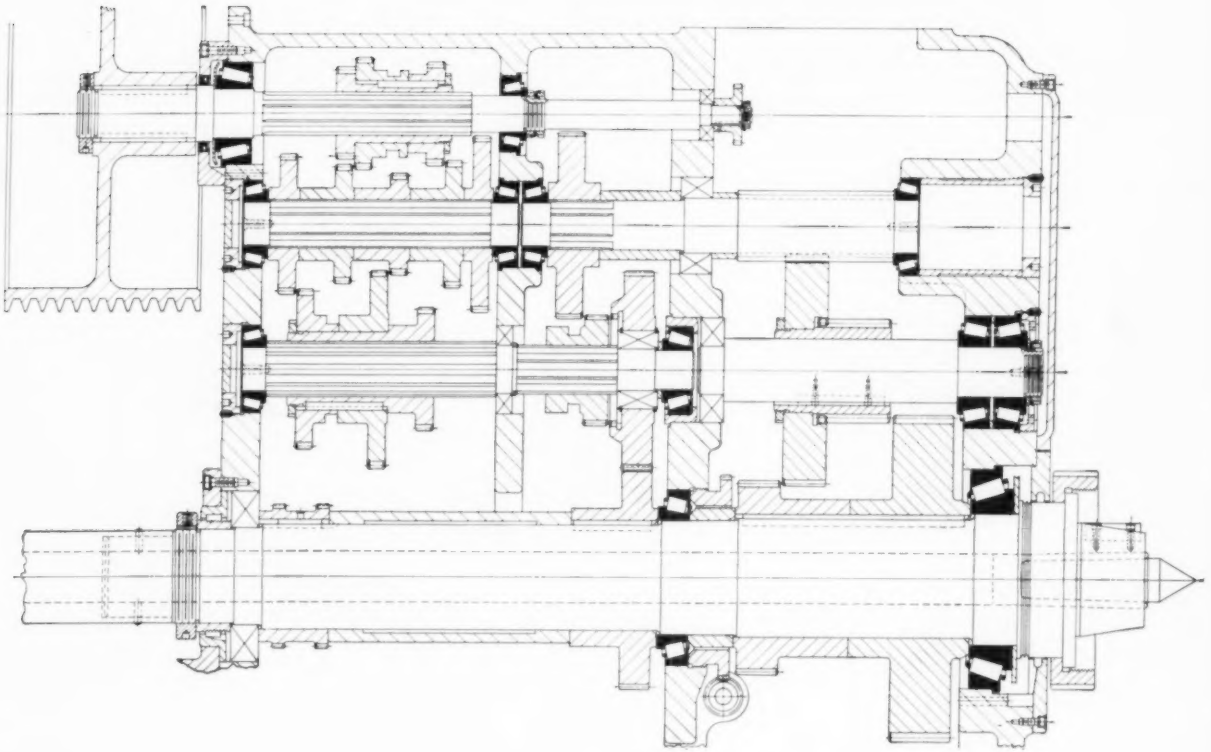
Cincinnati 14, Ohio

LUNKENHEIMER®

THE ONE Great NAME IN VALVES

Circle No. 86 on Readers' Service Card

How world's largest tracer lathe assures precision



Engineers of The American Tool Works Co. design maintenance of high precision right into their new Maxi-Swing Tracer Lathe with 16 Timken® tapered roller bearings on the nose and center of the spindle, drive and intermediate shafts. That's because Timken bearings are designed and manufactured to take the big loads from all directions of this machine cutting ¾" deep into work pieces of up to 40 tons. And they do it through a range of 22 speeds, giving rigidity with compact mounting and ease of assembly.

ON-THE-SPOT ENGINEERING SERVICE. Our sales engineers can help you right at the design stage to get the most economical bearing in terms of needed capacity and precision. Why not call them in early?

Industry rolls on

TIMKEN®

tapered roller bearings

The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO". Makers of Tapered Roller Bearings, Fine Alloy Steel and Removable Rock Bits. Canadian Division: Canadian Timken, St. Thomas, Ontario.

Circle No. 126 on Readers' Service Card